S·A·E Journal

MARCH, 1945

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc.

SAE JOURNAL *Pre-Prints*

THE SOCIETY OF AUTOMOTIVE ENGINEERS, INC.
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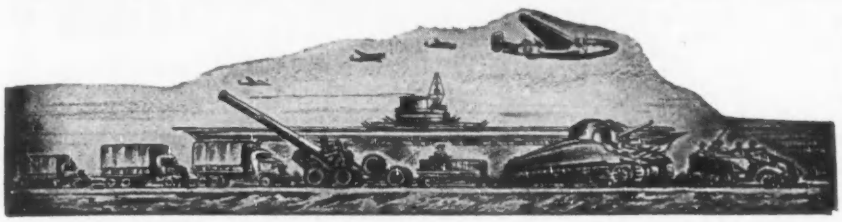

News of the **APRIL** *Issue*

By Norman G. Shidle

As Others See Us

THE gift of seeing ourselves as others see us is a questionable blessing. The trouble with most people is inability to see themselves any other way. Adverse opinions make timid men fearful. Outside approval stirs bold men to over-reach themselves. Unrelated to clearly formed objectives of our own, the gift can easily confuse or mislead—or both.

One associate will see us as efficient because we drive hard at every problem; another as inefficient for the same reason. To one man we seem kind if we help him to help himself; to another, cruel if we demand effort on his own part. One outsider sees us as foolish; another as wise—depending upon how our deeds affect *his* interests, personality, or aims. Many outside reactions are little more objective in character than our own opinions about ourselves.

Spending too much time on how others see us can substitute hesitation for decisiveness, fear for boldness, boldness for caution, querulousness for confidence, defense for attack, attack for defense . . . at the wrong time and in the wrong proportions. An effective man is infrequently a good chameleon.

Some clear notion of where we are going and why is more important to balanced living than what other people think about our actions. Outside opinions of conduct are useful only when applied to some inner reference point set up by ourselves.

The man who truthfully can say "I am the captain of my soul" is best equipped to handle an affirmative response to Bobbie Burns' invocation that some power "the giftie gie us to see oursels as other see us."

Selected editorials by Mr. Shidle have been published under the title, "For the Sake of Argument."
This book is available to SAE members at 50¢, to non-members at $1, from Special Publications Department, Society of Automotive Engineers, 29 West 39th St., New York 18.

Fuel Injection Promising Higher Engine Efficiency

MODERN phase of the eternal engineering argument over technical features of the internal-combustion engine appears to concern fuel injection versus carburetion. It looks as if engineering progress, having made the full cycle, is preparing to select fueling apparatus and methods as next in line for improvement.

Damning the carburetor is neither new nor novel, but this time the provocative factor seems to be war in the air, which is demanding the last full measure of horsepower from every ounce of fuel, planes and engines better than the enemy's, however narrow the margin of superiority.

That thin edge of performance superiority, for instance, will be one of the arguments for fuel injection to be advanced in April *SAE Journal* by F. J. Wiegand and D. W. Meador, of Wright Aeronautical Corp. They will explain that fuel injection, particularly with aircraft engines of 1000 bhp and more, offers advantages over carburetion which cannot be overlooked. Use of fuel injection, for example, can give a saving of 118% of the fuel cost on a 4-engine airplane operated for 400 miles at 15,000 ft.

They will describe tests which point the way to reduced fuel consumption and operating costs, to increased power production and payload. These multiple benefits, they will insist, result from tailoring the fuel supply for each individual cylinder instead of jeopardizing the efficiency of the entire engine by catering to the weakest cylinder.

The writers will suggest the possibility first of eliminating backfire dangers and then of using safety fuels, advantages which they will say offset fuel injection's higher initial cost, increased weight, and careful maintenance requirements. Further interesting suggestions will be that cylinder-head fuel injection, plus water injection, answers the military's demand for stretching performance under emergency conditions, and opens the way to further progress in engine output and performance.

Engineering Needs Disclosed By High Altitude Research

NEW and interesting field of research has been found in the regions 35,000 ft and more above the earth, where continuous operation of aircraft discloses difficulties not elsewhere encountered.

The stratosphere's low temperatures and pressures, for instance, demand an increase of 50% in the normal tension on control cables merely to take up slack. Lubricants must resist melting at high temperatures, yet must assure prompt functioning of trim tab controls and bomb doors which otherwise would operate only at a 200% increase in time.

Oil foaming becomes so troublesome as to jeopardize engines and to cause wholesale waste of lubricants. Electrical systems encounter such operating difficulties as to make redesign mandatory.

These and other details of flight tests above the clouds will be described in April *SAE Journal* by Test Pilot Marvin L. Michael and Flight Test Analysis Engineer Sidney R. Silber, of Boeing Aircraft Co. Among their helpful recommendations will be suggestions for the design of equipment and preparation of test crews for high-altitude research, including the use of the pressurized cabins which have made possible as many as three test flights daily in B-29's.

The Cover

WHEN we commissioned Lili Rethi, internationally-known Viennese artist, to draw a series of 12 covers for the *SAE Journal,* each picture representing a different activity of the Society, we knew that two things would happen. Our magazine would be more attractive, and the reputation of our organization would be enhanced by Miss Rethi's ability to capture the full spirit of the work in which we are engaged.

Miss Rethi is recognized on the Continent, in England, and in the United States as one of the outstanding industrial artists of our time. Without sacrificing truth for beauty, her drawings of buildings, bridges, airports and other man-made creations are a harmony of strict detail combined with picturesque loveliness. It is little wonder, therefore, that her posters have made history in both artistic and engineering circles.

Before the war she worked in Austria, Czechoslovakia, Germany, Holland, Belgium, Sweden, and England, where her masterful conceptions of the Scottish, Eastern and Danish Railways were counterbalanced by her warmly sensitive sketches of churches and old buildings.

In 1939 Miss Rethi was sent to this country by the *Illustrated London News* to draw a series of sketches of the World's Fair. Attracted by America's industry, she remained here to portray that aspect of our life – and is now an American citizen.

We believe that the pictures which will appear throughout 1945 on the covers of the *SAE Journal* rank with her best. They are representations not only of the Society's work, but of our very age, told with the simple strength and dignity of one who understands its meaning.

■

An endless procession of military vehicles forged in the automotive workshops of democratic America furnishes the motif for Miss Rethi's first SAE Journal *cover.*

Hundreds of thousands of horsepower stand ready for new service in the impressive array of motorized war equipment assembled in a single outdoor motor pool. Other millions of units and billions of horsepower will pour from automotive plants until the last Axis gun is silenced.

Sensitive Air Flow Devices Warn Pilot When Stalls Impend

CHANCES are that no airplane pilot ever took the time to warn his crew that an incipient breakdown of smooth airflow over airfoil surfaces impended. Instead, he would shout that the plane was going into a stall and devote the seconds thus conserved to remedial action.

As serious to the airplane pilot as a skid to the motorist, a stall means loss of flying speed, temporary loss of lift and control, frequently under unpredictable conditions and not infrequently with undesirable results. Obviously, any device forewarning pilots against stalls could be considered essential to safety.

That is how R. D. Kelly, of United Air Lines, Inc., will describe newly developed stall warning devices in April *SAE Journal.* Behind the rather forbidding title, "A Means for Warning of Incipient Breakdown of Smooth Airflow Over Airfoil Surfaces," will be a peculiarly interesting and not too technical story of the successful application of airflow sensitive units to the aft portion and low-pressure side of the airfoil. By ammeter or lights on the instrument panel the pilot is warned of the progressive incidence of stall conditions and dangers.

Icing, inadequate speed, excessively tight turns, Mr. Kelly will say, are among the dangerous conditions of which the pilot is warned. Surprise safety dividend will be reported as aid given to safe take-offs. The devices indicate also when the plane has attained sufficient speed to become safely airborne.

Wartime Changes in Fuels Cause Operating Troubles

WARTIME sacrifices of the civilian population include certain characteristics of motor fuels which once contributed greatly to the operating efficiency of motor vehicles, and whose lack makes for rather serious operating difficulties. Impaired performance is said to result directly from declines in fuel volatility and in antiknock properties, with starting troubles growing apace.

The situation constructively will be discussed in April *SAE Journal* by Professor W. H. Paul, of Oregon State College. His comparative analysis of pre-war and wartime gasolines will incorporate suggestions for overcoming present difficulties.

Advocate Power Steering For Safe, Easy Handling Of Large Motor Vehicles

CONTINUING engineering battle for the last available percentage of machine efficiency has invaded the terrain of motor-vehicle steering. Advance scouting discloses that here engineering aims are somewhat at cross purposes. They seek to make the operation a matter of mind rather than muscle, but without reducing the degree of control.

The present picture shows that steering ratios of 24 to 1 for passenger cars and of 40 to 1 for commercial vehicles have reached upper limits, yet steering-wheel pull still may go as high as 60, 80, or even 100 lb to overcome road wheel torques of as much as 600 to 6000 ft-lb.

One suggested solution for the problem, to be outlined in April *SAE Journal* by Francis W. Davis, consulting engineer, of Waltham, Mass., is power steering. Mr. Davis will report that power steering promises steering luxury for passenger cars, greatly reduced driving labor for commercial vehicles, and is even more helpfully applicable to the large, heavy-duty, and off-the-road vehicles which are finding wide usage during the war and may be expected to serve even a wider field post-war.

Mr. Davis will explain he is interested not merely in making life easier for the motor-vehicle operator, but is thinking in terms of driving safety for all vehicles and of the possibility of redesigning commercial vehicles for increased capacity and serviceability.

Heavy-Duty Engine Oils Put to Tests In War's Crucible

ADDITIVE, or heavy-duty, engine oils, just coming into general use as premium-grade lubricants before the war, are proving their qualities in the tough test of service, it will be reported in April *SAE Journal* by Major W. B. Bassett, of the Office of the Chief of Ordnance.

Major Bassett will describe tests, such as the 5000-mile run for Army cargo trucks without change of oil and with crankcase temperatures maintained at 280 F and other field and laboratory tests in which the new oils have met all operating requirements for both gasoline and diesel engines.

One of the happy surprises, Major Bassett will say, is the ability of these oils to accommodate crankcase dilution with gasoline as a cold-starting aid. Both field operations and tests will be reported to have revealed that even with a 30% dilution, engine parts remain in excellent condition, no harmful effects are evident, and engines start readily in overnight temperatures down to –50 F.

SAE Journal

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CONTENTS

MARCH 1945

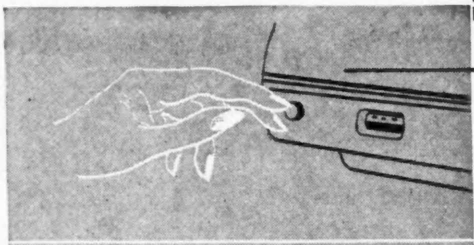
Eclipse

specialists . . . IN EVERY TYPE OF STARTING

All over the world, in every form of transportation, in the air, on the land, on the sea and under the sea, Bendix Starter Drives are acclaimed *most dependable—most adaptable*—and *most economical.* Over sixty-five million installations underscore its widespread acceptance.

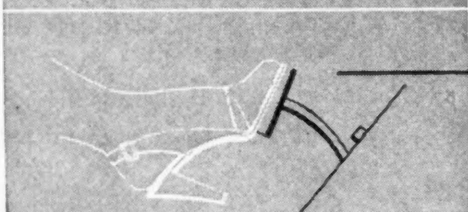
In the field of automotive transportation, through the Bendix Starter Drive, Eclipse not only helped to pioneer the self-starter but through the years has developed many improvements in starter drive performance and design.

For a solution to postwar starting problems, the automotive industry can look with assurance to Eclipse—specialists in every type of starting.

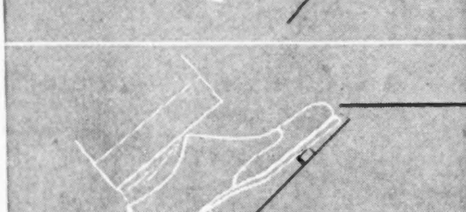


PUSH BUTTON—Conveniently located on the dashboard, Push-Button starting with Bendix Starter Drive is especially preferred by women for its neatness, visibility and extreme ease of operation.

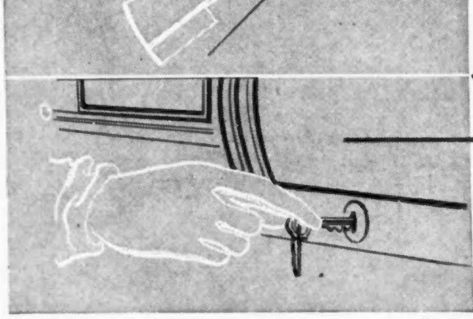
It is simple to operate . . . inexpensive to install . . . easy to service. Dependable and universally adaptable.



CLUTCH PEDAL—Many appreciate the safety and convenience of Clutch-Pedal starting. The engine is always started in "neutral"—hands are free to operate choke, throttle, etc.—and cold weather starting is quickened by clutch depression.



FLOOR BUTTON—With Bendix Starter Drive, Floor-Button starting is in wide use today on all types of pleasure and commercial vehicles. It is easy to locate with the foot—simple to operate . . . simple and inexpensive to install and service . . . and leaves both hands free to operate throttle, choke, etc.



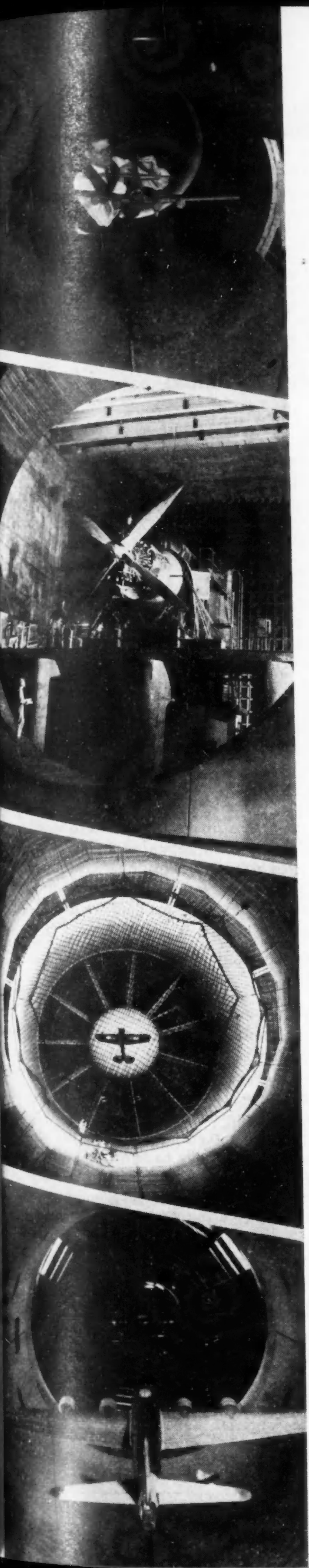
AUTOMATIC—Startix, or "Switch-Key" starting, is the simplest form of *automatic* starting. Its strong points of "user-acceptance" are ease of operation (once the ignition key is "on" Startix is in automatic control of your engine) . . . and that the engine is kept running at all vital times—heavy traffic, on hills and railroad grade crossings.

It is engineered to provide just the right time interval between engine stop and re-starting. It entirely eliminates the starter button and positively prevents accidental starter engagement.

Bendix Drive

ECLIPSE MACHINE DIVISION

BENDIX AVIATION CORPORATION ELMIRA, NEW YORK



RESEARCH *guarantees* FREEDOM

by BRIG.-GEN. F. O. CARROLL
Chief, Engineering Division, Air Technical Service Command, AAF

THE U. S. Army Air Force is the greatest armada ever conceived. Yet it is no lucky accident that we should have the most powerful Air Force in the world. The first World War brought the realization that a research organization was necessary to guarantee progress of military aviation in this country. To this end the experimental laboratory at McCook Field, Dayton, was established. Originally housed in an old wooden hangar, it has expanded into the modern plant of the Engineering Division of the Air Technical Service Command at Wright Field with 12 different laboratories working on the design, development, or test of aircraft or aircraft equipment. Here every piece of Air Forces equipment, from the smallest rivet to a Superfortress itself, is tested and tested again. Here all AAF equipment is matched against the most exacting specifications – and Wright Field is never satisfied. When an airplane is considered good enough to go into production, we then strive to make it better. And when we get it better, we try to make it better than it is. Between ourselves and the aircraft industry we have the grandest bunch of dissatisfied engineers in the world today.

In these days of rapid scientific strides, our very existence depends on out-thinking our enemies in research. Our creative thinking must be at least three years ahead of theirs – that is the approximate time lapse between the specifications and the first production model.

Development of the B-29 is an excellent example of how far ahead we must keep our research horizons. In 1939 the United States was still at peace. We had only a skeleton Air Force. Our flyers had a small handful of B-17's, but the standard bombardment airplane at that time was the Douglas B-18. Yet it was then necessary to envision the strategic and tactical considerations which would apply three or four years later when we would be able to get a new model into production. So it was then that the specifications for what is now known as the Superfortress were drawn up.

Of prime importance was the requirement that this plane should be capable of prolonged operations at an altitude in excess of 30,000 ft. That requirement brought up some of the toughest problems that our research men have ever faced.

Two phases of extensive AAF research at Wright Field are shown in this panel. Top: Historic 5-ft McCook Field wind tunnel is constant with models. Second from top: Engine test on one of huge dynamometer stands. Third: Looking up from base of new vertical wind tunnel through the nylon net installed to catch models when tests are finished. Bottom: Another view of the ancient McCook Field wind tunnel used on scale models

Let us look at some hurdles that research took before the B-29 could take to the air. Effects of reduced temperatures and pressures had to be counteracted because they influenced the operation of nearly every component of the aircraft and also had a definite effect upon the men who flew in them. As atmospheric pressure goes down the horsepower of an engine is cut proportionally. Its sea level output is reduced 50% at an altitude of 20,000 ft. Turbosuperchargers were designed and problem number one was disposed of.

Ingniton Problems Generated

Ignition systems also were affected by high altitude. If we maintain the same high pressure within the cylinders at high altitude that we normally maintain at sea level, then the ratio between the internal pressure and external pressure is increased. Electricity following the path of least resistance will tend to "arc over" somewhere in the low pressure area outside the cylinders rather than leap the spark plug gap and ignite the compressed gasoline vapor. Electrical engineers went to work and developed new insulating materials with higher dielectric characteristics, and redesigned the ignition harness to increase creapage distances.

We now have sufficient manifold pressure and the ignition system is operating, but reduction in pressure has caused the gasoline in the tanks and fuel lines to vaporize causing fuel loss and formation of vapor-lock. Design of tank and booster pumps took care of these problems.

The thin air at high levels gives insufficient cooling and the whole problem of heat transfer is opened. The research boys go to work again and redesign the cowl flaps, oil coolers, and the ducting around the cylinders. Others develop new materials which will withstand higher operating temperatures, and we at last have some of the engine problems pretty well in hand. Thus simultaneous research in all fields is necessary to keep our scientific progress from faltering. One missing link may hold up an entire program.

But the human mechanism must be provided for as well. To keep up the human manifold pressure, to use a simile, pressurized cabins were designed for the B-29. A pressure cabin eliminates wearing oxygen masks on long missions by maintaining a simulated altitude below 12,000 ft, or to prevent bends by maintaining a simulated altitude below 30,000 ft. The B-29 may be operated with a pressure differential up to 6.5 psi. This permits operation up to 30,000 ft while maintaining an 8000 ft cabin altitude.

It was originally thought that if shell fire penetrated the pressurized area, the sudden drop in pressure would cause serious injury to the air crew. Some contended that a man's eyes might pop right out of his head. The Aero-Medical Laboratory made conclusive tests on explosive decompression, as this phenomenon of suddenly reduced atmospheric pressure is called. A mock-up cabin was equipped with an oxygen system, a communication system, and a time-pressure recorder designed to make an accurate time tracing of rapid pressure changes. To assure a complete record, high speed motion picture cameras were also installed. The cabin was placed in a high altitude chamber. A volunteer entered the cabin and this exciting simulated flight was begun. Pressure was maintained within the cabin equal to that existing at approximately 10,000 ft, whereas, the pressure outside the cabin was reduced to that existing at an altitude of 35,000 ft. Doors with heavy paper apertures of different sizes, made it possible to suddenly puncture the cabin and reproduce the condition of explosive decompression flight. This test was performed more than 150 times on different people and there never were any bad effects. The pressure differential here was the same as that used in a bomber, 6.55 psi. The decompression rate (87 lb per sec) was the same as would be produced if a pressure cabin of 1000 cu ft volume was ruptured with a 5½-ft diameter hole.

Cabins Are Pressurized

Pressurized cabins are now taken as a matter of course by the boys in the B-29's. One B-29 crew, flying across the hump from India to China, had a failure in one of the scanning blisters. A quick-witted gunner thrust a seat cushion into the hole and the flight was completed without loss of cabin pressure. In fact, they were so busy that they made several flights before replacing the blister.

Placing the men in a pressurized cabin did not solve all the problems. The turrets and guns had to be operated. It was impractical to pressurize the entire fuselage so we had a choice of building pressurized cabins for each gunner or to build a large central cabin and design a remote fire control system. The latter gave the gunner better visibility, more comfort and more protection from enemy fire. The system also includes the automatic correction for altitude, temperature, ballistic characteristics of the ammunition, and the speed of both the B-29 and the attacking planes. These factors are all automatically determined by the computer during tracking, and instantaneous and proper adjustment is made in the aim of the guns. Until recently there was a legitimate question as to whether one could actually shoot down attacking fighters with such remotely controlled armament. Headquarters communiques from the combat areas seem to show that the fire control system is working out even better than we had hoped.

Performing Difficult Tasks

This plane today is accomplishing the most difficult missions which have so far been assigned to any Air Force. The B-29's of the 20th Air Force, for example, are based in India and to carry out a mission against Japan must fly over the hump to advance bases in China, refuel and fly on to Japan. The run to Tokyo, Yokahama, or Kobe must be made alone, counting on altitude, speed, and the skill of their gunners to get them through. After dropping their bombs the crews must fly back to their China bases, refuel and take off for India as quickly as possible so as to protect their planes from attack on the ground by Japanese based only a few miles away. Only the B-29 is at present capable of carrying out such a task.

The tasks that confronted these research men seemed impossible of accomplishment at the time, but somehow a solution was found for every problem. Nor has the task ended. Whenever a plane, an engine, or a piece of equipment accomplishes a required test without difficulty then it is decided that it is not rated high enough, and up go the standards. Nothing can be allowed to rest on its laurels. Research must not only create new aircraft designs but must provide the American fighting men with every tech-

(This paper, "Some Steps in the Development of an Air Force," was presented at the SAE War Engineering-Annual Meeting, Detroit, Jan. 10, 1945)

ological improvement to guarantee that their mission will e a success and that they will return safely to base.

Automatic Navigation

A new development makes it possible for a pilot to enter mbat or take evasive action from enemy aircraft or flak d forget about his navigation. By means of an air posion indicator he has an automatic indication of his position an air plot. He knows his latitude and longitude in lation to the air in which he is flying. This is not his sition in relation to the ground, but that may be detered by subtracting the wind vector. This device would ermit a navigator in a bomber to relieve temporarily a unner without losing track of the location of his aircraft.

The B-29 carries more than 20 radio sets and devices. This provides for all eventualities in the way of communiation, navigation or identification requirements. Radio eams guide our pilots into bases established around the orld. Direction finders give further assistance and also elp to locate those who perchance have been forced down pon the ocean, the arctic wastes, the desert, or jungle.

It has always been an Air Force policy to protect its ersonnel to the utmost. On long over-water hops, like the ne from Saipan to Tokyo, planes are equipped with life afts, but research is constantly being carried on to provide he men protection against the elements and to provide ustenance. Drinking water is the first thought. A new till has been developed that can be folded up and stuck in ne's pocket. All it needs is a few hours of sunlight for vaporation. When there is no sun, chemical de-salting gents are used.

An interesting sidelight on portable transmitters is that evelopment work carried on by two combat men stationed in the South Pacific where locating a tiny dot of a life raft somewhere on the trackless miles of ocean was a real problem. Both of these men had had radio experience in civil life. They went to work to build emergency rescue sets out of salvaged parts from standard aircraft radio sets. Their improvised equipment worked so well that their commanding officer sent them back to Wright Field where they could help design a practical and light weight set. Radio engineers in the Laboratory were already at work on a similar project. Combining the intimate knowledge of the combat men with that of the laboratory research workers has brought about a new device which we hope will assist in the quick rescue of many of our men who may be forced to "ditch" their planes and take to the rubber boats.

Over the land as well as over the sea our men are supplied with survival kits containing the things that will be the most valuable in carrying on life until rescue can be effected.

Bigger Craft Coming

Bigger and faster airplanes are on the drawing boards; engineers and scientists are at work solving new problems that when solved will translate our engineering dreams into realities. Every day reveals new scientific possibilities. Through research new developments are cascading one after another. We have built up what might be called "research momentum."

The more we advance, however, the more critical we become. What is good enough for today will not be acceptable tomorrow. No matter what the disposition of aerial strength may be after the war; no matter how certain peace terms may seem to make future wars impossible, research which means preparedness, must be continued.

Research is our aviation insurance. We dare not let a single premium lapse.

In the 20-ft 450 mph wind tunnel control room at Wright Field Brig.-Gen. F. O. Carroll, directs a test of new equipment. Homer Jacobs, veteran civilian engineer, operates the control board while Major C. A. Lutz studies operations for further test procedure

Navy Honors John F. Creamer

John F. Creamer (right), chairman of the board of Wheels, Inc., New York City, and a past-chairman of the SAE Metropolitan Section, is shown being presented with the Meritorious Civilian Service Award of the U. S. Navy Bureau of Yards and Docks by Com. J. F. Jelley (CEC), USN, while Furber Marshall (center), president of Pharis Tire & Rubber Co., looks on. The citation, which was signed by Vice-Admiral B. Moreell (CEC), USN, was given to Mr. Creamer, who is the first automotive executive engineer outside of the Navy Department to be thus honored, "in recognition of excellent services rendered over and beyond those normally required in connection with his duties in the construction program of this Bureau"

About SAE Members

FREDERICK ULLBERG, JR., is now district manager, Metals & Alloys, New York City. He had been in the publicity department of Edward G. Budd Mfg. Co., Philadelphia.

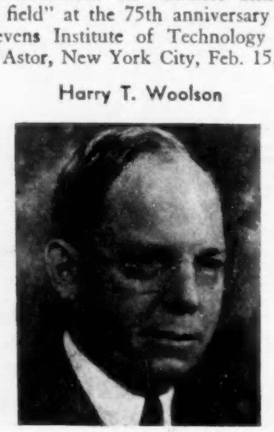
CHARLES W. HAMMOND, formerly test engineer, Eastern Aircraft Division, GMC, Linden, N. J., is now a mechanical engineer for Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J.

R. E. ROOT, U. S. Army Air Forces, has been transferred from Lowry Field, Colo., to the 4000th AAF Base Unit – Section BJ, Wright Field, Dayton, Ohio.

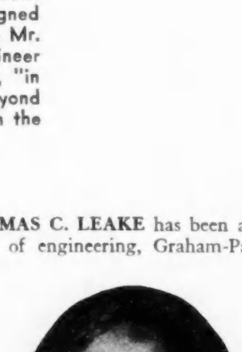
Previously president, California Commercial Co., Inc., New York City, **H. G. DENHAM** is now connected with Arabian American Oil Co., San Francisco.

SAE PAST-PRESIDENT HARRY T. WOOLSON, executive engineer, Chrysler Corp., was awarded with the Stevens Honor Award Medallion for "notable achivement in his field" at the 75th anniversary dinner of Stevens Institute of Technology at the Hotel Astor, New York City, Feb. 15.

Harry T. Woolson



THOMAS C. LEAKE has been appointed director of engineering, Graham-Paige Motors Corp., Detroit. He was formerly chief engineer of the organization.



Thomas C. Leake

HENRY J. ANTOSZ, previously metallurgist and engineer, Lear, Inc., Piqua, Ohio, is now technical supervisor in operations, Fercleve Corp., Oak Ridge, Tenn.

VERNON B. BENFER is now in the U. S. Navy, stationed at San Diego, Calif. He had been production engineer, Lockheed Overseas Corp., Aircraft Engine Overhaul Division, A. P. O. 636, New York City.

F. W. LAMPE, formerly head of the product development department, CAG Products, Inc., Dearborn, Mich., is now engineer in charge of styling and designing, Knu-Vise, Inc., Detroit.

CHRIS H. BOUVY, who had been design engineer, Cadillac Motor Car Division, GMC, Detroit, is now chief design engineer, Le Roi Co., Milwaukee, Wis.

KENNETH E. BLANCHARD, who had been supervisor of production, Army Service Forces, New York Ordnance District, is now with The Texas Co., New York City, as automotive engineer.

ABRAHAM I. STERN has joined Stratos Corp., Babylon, L. I., N. Y., as test engineer. He had been associate mechanical engineer, U. S. Army Air Forces, Air Technical Service Command, c/o Packard Motor Car Co., Detroit.

F. C. CRAWFORD, president of Thompson Products, Inc., Cleveland, was elected president of the Automotive and Aviation Parts Manufacturers, Inc., at the annual meeting of the association's board of directors. **J. L. MYERS,** executive vice-president, Cleveland Graphite Bronze Co., was named secretary-treasurer, and the following SAE men were elected as new directors: **WALTER ROCKWELL,** president, Timken-Detroit Axle Co.; **W. A. BAKER,** president, Firestone Steel Products Co.; and **D. H. KELLY,** executive vice-president, Electric Auto-Lite Co.

ACF-Brill Advances

F. W. Kateley (right), has been promoted from motor coach engineer to chief engineer

E. G. Mathauer (left), has been raised from the position of new development engineer to assistant chief engineer

JACK JEROME, formerly design staff engineer, Consolidated Vultee Aircraft Corp., ...ee Field, Calif., has been named chief ...gineer, Airex Mfg. Co., Inc., Long Island ...y, N. Y.

JOSEPH GESCHELIN, Detroit, editor, ...lton Publications, is scheduled to address ...e Industrial Marketers of Detroit and the ...men's Advertising Club of Detroit on the ...jects of post-war market potentialities and ...t-war products for the automotive industry in February and March, respectively. He ...a former SAE vice-president for Production Engineering.

SHERMAN VANNAH, previously senior ...t engineer, Lawrance Aeronautical Corp., ...den, N. J., is now special engineer, Air-...oled Motors Corp., Syracuse, N. Y.

Formerly airport manager, Pan American ...ce Airways, Inc., Lima, Peru, STAN-...RD V. BURBERICK is now service engi-...r, Kinnear Mfg. Co., San Francisco.

HARRY M. WHITTAKER has been ap-...nted sales manager, Hydraulic Division, ...co Corp., Detroit. He had been execu-...e vice-president, Micromatic Hone Corp., ...ne city.

RALPH M. WERNER is now connected ...h United Parcel Service, New York City. ...e was formerly experimental engineer, ...rd La France Truck Division, Elmira, ...N. Y.

GEORGE A. BEATTY has been named ...al engineer, Pontiac Motor Division, Gen-...al Motors Corp., Pontiac, Mich. He had ...en design supervisor, Eastern Aircraft Di-...sion, GMC, Linden, N. J.

After more than 20 years of service with ...e American Petroleum Institute, DR. ...OSS P. ANDERSON resigned Dec. 31 ...en his active career in the technical de-...lopments of the industry to retire on a ...m in Chester County, Pa. Born in Wayne ...unty, N. Y., he taught at Cornell follow-...g his graduation there, and served as chief ...emist for United Natural Gas Co., Oil ...ty, Pa., before joining API, as secretary ...f the Refining Division. In this capacity ...e served on a number of technical com-...ittees of the American Society for Testing ...terials, American Standards Association, ...tional Fire Protection Association, and ...s been treasurer of the Coordinating Re-...rch Council, Inc., supported jointly by ...e API and SAE.

HUGH W. MELDRIM has recently joined ...ific Airmotive Corp., Burbank, Calif., ...magneto mechanic.

JACK C. D. MANES may be reached at ...neral Motors Truck & Coach Division, ...s Angeles, where he is service manager ...the West Side store.

Heads of New Tapco Division

Harry D. Bubb (above), heads Thompson Aircraft Product Co.'s new Jet Propulsion & Turbine Division as manager. He had been director of all Thompson plants

Robert E. Cummings (below), formerly valve engineer, is now sales engineer of the Division

Emil Gibian (above), is in charge of the Jet Propulsion & Turbine Division's operating staff as chief engineer. Previously he was chief engineer of Tapco.

W. V. HANLEY is now with Standard Oil Co. of Calif., Aviation Division, San Francisco, as technical representative. He was formerly engineering test pilot, Intercontinental Division, Transcontinental & Western Air, Inc., Wash. Mr. Hanley is a former vice-chairman of the SAE Northern California Section.

WALTER BISHOP is no longer personnel manager, Wadell Engineering Co., Orange, N. J., having joined Industrial Relations Counselors, Inc., New York City, as staff assistant. Mr. Bishop is now serving as chairman of the SAE Placement Committee as well as a member of the SAE Student Committee.

EARLE F. TRAISE, who had been associated with Wilkening Mfg. Co., Philadelphia, is now on the staff of Buckeye Service & Supply Co., Cincinnati.

PAUL C. ROCHE has changed his position from chief field engineer, Lord Mfg. Co., Erie, Pa., to product engineer, Nosco Plastics Division, National Organ Supply Co., same city.

Formerly superintendent, Walker Gage & Die Co., Detroit, THOMAS OLIPHANT is now chief engineer, Progressive Industries Co., Detroit.

CARL E. MEYERHOEFER has resigned from E. A. Laboratories, Inc., Brooklyn, N. Y., where he was employed as chief engineer, to join the staff of the Mechanical Division, Lewyt Corp., same city, as chief mechanical engineer.

...chard C. Adams (right), who ...d been production control manager of S. K. Wellman Co., Cleveland, has been promoted to president of S. K. Wellman Co. of Canada, Ltd., Toronto, Ont.

WILLIAM J. MORELAND, who had been dynamometer engineer, Gulf Oil Corp., New York City, is now with Nash-Kelvinator Sales Corp., Nash Motors Division, same city, as service representative.

ENSIGN PAUL OVERBY, USNR, has been transferred from Miami, Fla., to the West Coast Sound School, San Diego, Calif.

NORBERT E. PENTZ, a former student of Ohio State University, is now in the U. S. Army, with the 1490th Engineering Maintenance Company, The Dalles, Ore.

F. A. QUACKENBUSH, who had been a lieutenant colonel in the U. S. Army Quartermaster Corps, Arlington, Va., is now district representative for GMC Truck & Coach Division, General Motors Corp., Pontiac, Mich.

LT. (jg) ROBERT H. THORNER, USNR, may be reached at Navy 128, Box 1314, c/o Fleet Post Office, San Francisco. He had been stationed at the Philadelphia Navy Yard.

Previously connected with Kellett Aircraft Corp., Upper Darby, Pa., RAYMOND B. LANDIS is now in the U. S. Army, stationed at the 4000th Army Air Forces Base Unit Section Battalion, Wright Field, Dayton, Ohio.

ALPHONSE F. SIERS, formerly product engineer, J. G. Brill Co., Philadelphia, is now chief engineer of the Automotive Division, Pesco Products Co., Cleveland.

JOHN H. PIKUS, who had been an automotive technician, Maintenance Engineering Division, U. S. Army, Holabird Ordnance Base, Baltimore, Md., is now head of the industrial-vocational department, Frankfort Community High School, West Frankfort, Ill.

EDWARD S. CHRISTIANSEN has been named president of Magnesium Co. of America., Inc., Chicago. He was formerly vice-president, Apex Smelting Co., same city.

CHRISTIAN E. GROSSER, formerly assistant professor of mechanical engineering, M. I. T., Cambridge, Mass., is now vice-president and chief engineer, Standard Machinery Co., Providence, R. I.

JACK BARNES has resigned from Ford Motor Co., Indianapolis, where he was ser-

vice supervisor, to become affiliated with J. D. Adams Mfg. Co., same city, as process engineer.

Harvey S. Firestone, Jr.

HARVEY S. FIRESTONE, JR., president of Firestone Tire & Rubber Co., Akron, Ohio, has been awarded the degree of commander of the Order of the Star of Africa for invaluable service to the Republic of Liberia. The citation, conferred by President W. V. S. Tubman of Liberia acting as grand master of the Order, is the highest presented by the Republic, and is "an indication of the gratitude of the Government and people of Liberia for invaluable assistance rendered in the economic and social development of the Republic."

GEORGE P. SALADINO is now the proprietor of Saladino Sales & Service Station, Corona, L. I., N. Y. He had been field service representative, Curtiss-Wright Corp., Propeller Division, Caldwell, N. J.

HUGH O. PIERCE, USMCR, has been transferred from Miramar, San Diego, Calif., to Fort Worth, Tex., where he is connected with flight operations.

CHRIS H. WILL, who had been a designer in the research department, Holley Carburetor Co., Detroit, is now in the U. S. Army stationed at Fort Lewis, Wash.

DAVID W. WHITTLESEY, formerly associate mechanical engineer, U. S. Army Air Forces, Wright Field, Dayton, Ohio, is now in the U. S. Navy, and may be reached at the U. S. Naval Air Station, Patuxent River, Md.

S. B. RUSSELL has been appointed drawing-office manager, Chaseside Engineering Co., Ltd., Middlesex, England. He had been draftsman of the chassis section, John I. Thornycroft & Co., Ltd., Basingstoke, Hants, England.

LeROY F. MAURER is no longer assistant manager, Ordnance Division, Bell Aircraft Corp., Burlington, Vt., having joined Package Machinery Co., Baltimore, Md., as a manufacturers' representative.

SAE PAST-PRESIDENT W. S. JAMES has been appointed chairman of the Subcommittee on Highways and Motor Transportation of the Committee on Transportation of the China-American Council of Commerce and Industry, Inc. The purpose of the Council is to assist in maintenance of contact between American and Chinese industries and to assist in advising the United Nations Relief and Rehabilitation Administration in connection with Chinese relationships.

DOUGLAS McGREGOR is now associated with Pierce Governor Co., Inc., Anderson, Ind. He was formerly chief engineer, Indian Motocycle Co., Springfield, Mass.

CHARLES H. COLVIN, engineering consultant, has been elected president of the Institute of Aeronautical Sciences for 1945. SAE members who were elected vice-presidents include: **W. A. M. BURDEN,** Assistant Secretary of Commerce; **LEROY R. GRUMMANN,** president, Grumman Aircraft Engineering Corp.; **I. M. LADDON,** vice-president, Consolidated Vultee Aircraft Corp.; and **ARTHUR E. RAYMOND,** engineering vice-president, Douglas Aircraft Co., Inc. **MAJOR LESTER D. GARDNER** was re-elected chairman of the Council, and **ROBERT R. DEXTER** was re-elected secretary.

LT. LEE G. SNYDER, U. S. Navy, has been moved from the Naval Air Training Center at Corpus Christi, Tex., to the Naval Air Station at Patuxent River, Md.

CAPT. GEORGE A. DOOLE, master pilot with Pan American World Airways, was recently named assistant chief pilot in charge of personnel at the transatlantic headquarters, La Guardia Field, N. Y. He was formerly operations manager for the airline.

Capt. George A. Doole

G. GEOFFREY SMITH, managing editor of *Flight,* an English publication, has recently completed an enlarged 128-page version of his book "Gas Turbines and Jet Propulsion for Aircraft," which deals with thermal jet propulsion systems and surveys steam and gas turbines driving airscrews. Among the features of this new edition, published by Aerosphere, Inc., New York City, are 60% more illustrations (84 in all); chapters on turbine-compressor units and boundary layer control; and an introduction by **T. P. WRIGHT,** Administrator of Civil Aeronautics, U. S. Department of Commerce, whose pertinent comments on the importance of gas turbines and jet propulsion to future air progress contribute much to the value of this book.

Formerly associate engineer, Armour Research Foundation, Chicago, **DANIEL BROWN** is now in the U. S. Army, and may be reached at Camp Hood, Tex.

W. G. WALTERS has been appointed to the engineering staff of Mack Mfg. Corp.'s Research Division, Plainfield, N. J. He had been an engineer in the experimental test department, Chevrolet Aviation Engine Plant, Tonawanda, N. Y.

CLYDE R. JONES is now a captain in the U. S. Army serving as technical representative for Packard Motor Car Co. of Detroit. In civilian life he was in the Experimental Division of Douglas Aircraft Co., El Segundo, Calif.

LT. JOSEPH P. VAN OVERVEEN has been transferred from Fort Knox, Ky., to overseas duty, and he may be contacted at A. P. O. 18237, c/o Postmaster, San Francisco.

Previously director for the Ministry of Munitions, Melbourne, Australia, **ALFRED R. CODE** is now deputy director-general (engineering), Ministry of Supply, London, England.

CURTIS E. LUNBLAD is now a second lieutenant in the U. S. Army, stationed at Chanute Field, Ill. He recently completed the Army Air Forces aircraft maintenance engineering course at Yale University, New Haven, Conn.

V. J. JANDASEK has joined the staff of McCulloch Aviation, Milwaukee. He was formerly turbo engineer, Bendix Aviation Corp. Research Laboratories, Detroit.

FRANK L. GRANT, formerly sales engineer, Midland Steel Products Co., Cleveland, is now associated with Kelsey-Hayes Wheel Co., Detroit, as sales engineer.

SAE members who have been promoted within Warner Aircraft Corp., Detroit, are: **L. A. MAJNERI,** from chief engineer to vice-president in charge of engineering; and **W. A. WISEMAN,** from assistant chief engineer to chief engineer.

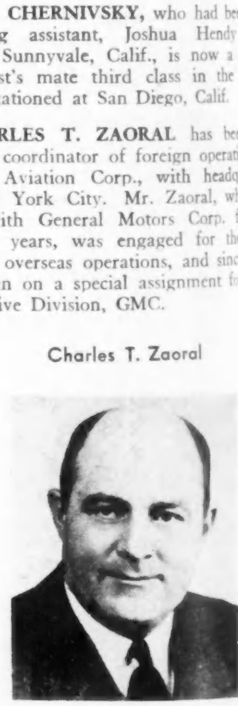
LT. SAMUEL UNTERMYER, II, who is in the U. S. Navy, has been transferred from the Mare Island Navy Yard, Calif., to Portland, Ore.

DR. OTTO ENOCH, previously research engineer, Ethyl Corp., Detroit, is now affiliated with Fram Corp., Providence, R. I., as project engineer.

V. A. CHERNIVSKY, who had been engineering assistant, Joshua Hendy Iron Works, Sunnyvale, Calif., is now a motor machinist's mate third class in the U. S. Navy, stationed at San Diego, Calif.

CHARLES T. ZAORAL has been appointed coordinator of foreign operations of Bendix Aviation Corp., with headquarters in New York City. Mr. Zaoral, who had been with General Motors Corp. for the last 15 years, was engaged for the most part in overseas operations, and since 1943 had been on a special assignment for Electro-Motive Division, GMC.

Charles T. Zaoral



HUGH L. HEMMINGWAY, formerly product engineer, Kendall Refining Co., Bradford, Pa., is now affiliated with Pure Oil Co., Chicago, as technical adviser, marketing department.

Previously a consultant in precision castings, Allis-Chalmers Mfg. Co., West Allis, Wis., T. C. KUHLMAN is now located in Detroit doing the same type of work.

JOHN W. THOMAS, chairman of Firestone Tire & Rubber Co. and directing head of its worldwide operations, was awarded the gold medal of the American Institute of Chemists, one of the chemical industry's highest honors, on Feb. 2. Announcement of the award, presented annually for "noteworthy and outstanding service to the science of chemistry or the profession of chemist in America" was made by **DR. GUSTAV EGLOFF,** president of the Institute and petroleum technologist of Universal Oil Products Co.

GEORGE S. LACE has resigned his position from Transportes Aereos Central Americanos, San Salvador, Central America, and is now with the aircraft branch, War Assets Corp., attending to the inspection of surplus aircraft and engines.

SAE members who have received promotions within the Armed Forces include: **ARTHUR H. DENISON,** district air inspector, Midwestern Procurement District, Wichita, Kan., to colonel; **EUGENE ROTH, TITUS E. FRANKENFIELD, ANDREW S. CURETON,** A. P. O. 512, c/o Postmaster, New York City, to lieutenant colonel; **DONALD M. ROSS** to major; and **HYMAN FELDMAN,** A. P. O. 7, San Francisco, **KEITH C. ALLEN, W. ARTHUR ROBIN,** Cherry Point, N. C., and **A. E. VALLIER, JR.,** Army Service Forces, Detroit Ordnance District, Lansing (Mich.) regional office, to captaincy.

In the Navy **PAUL H. GROULEFF,** c/o F.P.O. San Francisco, is now a commander; **LLOYD HENRY MULIT** and **ROBERT H. MILBRATH** have been raised to lieutenant commanders; **GUILBERT S. WINCHELL,** Naval Air Station, Quonset Point, R. I., is now a lieutenant; and **HARLOW A. TRIPLETT, FRED J. GRUMME** and **J. C. HUBBARD** have been advanced to lieutenant (jg).

R. L. HEATH recently joined Climax Molybdenum Co. as a metallurgical engineer, with headquarters in St. Louis, Mo. He was previously chief metallurgist, Allison Division, General Motors Corp., Indianapolis, Ind.

R. L. Heath

JOHN P. MANNING has been promoted from the rank of lieutenant to captain, and is now stationed in Washington, D. C.

LT.-COL. GEORGE ELLIS has received a discharge from the Australian Military Forces, Eastern Command, Moorebank, N.S.W., Australia, and has resumed his civilian occupation with General Motors-Holden's Ltd., Pagewood, N.S.W.

On military leave from the Army Air Forces, Lt.-Col. **GEORGE L. STETSON** is now products application engineer, Shell Oil Co., Inc., New York City.

G. TAYLOR MYERS, who was formerly a major, Ordnance Department, Chicago, is now a lieutenant colonel, A.P.O. 471, San Francisco, Calif.

Formerly second lieutenant, **SUMNER PAUL YOUNGBLUTT** is now captain, U. S. Army Air Forces, Newell, S. D.

LT.-COL. WILLIAM L. PURCELL has been appointed to serve as AAF resident representative at all Curtiss-Wright Corp.'s propeller plants. Lt.-Col. Purcell, formerly AAF resident representative at the corporation's

Lt.-Col. William L. Purcell

main propeller plant at Caldwell, N. J., will now oversee the uniform administration of Army Air Force business at not only the Caldwell branch, but also those located at Clifton, N. J.; Stamford, Conn.; Beaver, Pa., and Indianapolis.

JOHN M. THOME, formerly lieutenant (jg), now holds the rank of lieutenant (E) L, and is stationed at the Navy Yard, Mare Island, Vallejo, Calif.; **C. C. LAWTON** has been transferred from Army Quartermaster Corps, Camp Lee, Va., to Office of Quartermaster General, Chicago, Ill. He holds the rank of lieutenant colonel.

AUDRIEN J. BLOOMBERG, formerly production manager and engineer, Milsco Mfg. Co., Milwaukee, Wis., is now connected with Enger-Kress Co., West Bend, Wis., in the same capacity.

SAE Student Member **EDWARD SHAHINIAN** has joined the Navy. He holds the rank of ensign, and is stationed at the University of Colorado, Boulder, Colo.

Previously development engineer at P. R. Mallory & Co., **I. C. SLEIGHT** now holds the position of chief metallurgist, bearing division, same company, Indianapolis, Ind.

R. W. WARING has resigned from Sperry Gyroscope Co., Inc., Brooklyn, N. Y., as materials engineer, to become associated with

R. W. Waring

Bridgeport Brass Co. as chief engineer of the East Main plant. Mr. Waring is a member of the SAE Aircraft Accessory Materials & Processes Committee.

JAMES W. BILLINGS, JR., who was formerly a captain, Office of Ordnance Officer, Headquarters Air Service Command, is now a major, Ninth Air Force Service Command.

M. C. EMERINE, formerly a major, is now a lieutenant colonel; formerly an ensign, **THOMAS B. SHARAR, JR.,** now holds the rank of lieutenant (jg); **HARLAN KNOX PERRILL** has been promoted to commander, c/o Fleet Post Office, San Francisco, Calif.

On leave of absence from his former position of assistant professor of mechanical engineering at the University of Minnesota, **THOMAS EDWARD MURPHY** is now in the U. S. Naval Reserve and is stationed at the Aircraft Engine Laboratory, Naval Air Experimental Station, Naval Air Material Center, Philadelphia, Pa.

CHARLES W. FRANCE, vice-president and general manager, Curtiss-Wright Corp., Airplane Division, has been transferred from the Buffalo, N. Y., to the St. Louis, Mo., branch of the company.

Formerly senior test engineer, Wright Aeronautical Corp., Paterson, N. J., **WILLIAM H. DAWSON, JR.,** is now assistant project engineer, same company.

SAE members who have received recent changes in company status include: **FRANK L. DeCAVITTE,** Chrysler Corp., from superintendent, Aircraft Division, Plymouth Division, Detroit, to plant manager, Evansville, Ind.; **STUART P. MILLER** from plastics sales engineer, E. I. du Pont de Nemours & Co., Inc., Chicago, to plastics engineer of the Arlington, N. J., plant; **G. WAINE THOMAS,** Continental Motors Corp. executive engineer, has transferred from the Detroit to the Muskegon, Mich., branch: **JOHN BRENT WASSALL,** Lockheed Aircraft Corp., Burbank, Calif., formerly in charge of Factory "A" Engineering, is now chief production development engineer; **JOSEPH N. STANFORD,** from chief engineer, Douglas Project 19, to experimental flight test engineer, Douglas Aircraft Co., Inc., Santa Monica, Calif.; previously war products service manager, GMC Truck & Coach Division,

General Motors Corp., Pontiac, Mich., **A. A. SHANTZ,** is now general parts and service manager, same company; **WALTER F. WRIGHT,** formerly deputy regional director, in charge of Automotive and Ordnance Tank and Automotive Activities, is now chief deputy director, War Production Board, Detroit, Mich.; and **RALPH L. ELLINGER,** from chief engineer, Transcontinental & Western Air, Inc., Kansas City, Mo., to senior engineering representative for TWA on the Pacific Coast.

Also, **ARTHUR GEORGE BOOTH,** from chief chassis engineer, Humber, Ltd., Coventry, England, to technical engineer; **ARTHUR SYKES,** David Brown & Sons (Huddersfield) Ltd., Yorkshire, England, from technical manager, to engineering & sales controller; **HERBERT EUGENE CHAPLIN,** Fairey Aviation Co. Ltd., Middlesex, England, from chief designer to chief project engineer; **ALFRED CHARLES BARLOW,** formerly chief engineer, Fairey Aviation Co., Ltd., Middlesex, England, is now consulting and research engineer; **GWILYM WILLIAMS** is now manager of the technical department, Harold Andrews Grinding Co. Ltd. Birmingham, England; **JAMES EDWIN ELLOR,** Rolls-Royce, Ltd., Derby, England, from chief research and development engineer to assistant chief engineer – aeronautics; **PAUL De KUZMIK** is now special assistant to the president, Panair do Brazil, South America; and **JOSEPH JOHN DZIEWONSKI** formerly inspectorate general, technical branch headquarters, Polish Air Force, to technical consultant.

Also, **FRANK M. GORSUCH, JR.,** Holabird Signal Depot, Baltimore, Md., from instructor, to power engineer, salvage disposal division; **RAYMOND E. ROEHRENBECK,** Swan Finch Oil Corp., has been transferred from New York to Chicago, Ill.; **QUENTIN N. GROTH,** Thompson Products, Inc., Cleveland, Ohio, from industrial engineer to chief, standards engineer, aircraft accessories division; formerly general superintendent, Eastern Aircraft Division, **GMC, Linden, N. J., JOHN D. MacCARTHY** is now product engineer, Electro-Motive Division, GMC, La Grange, Ill.; **FRED T. BROOKS,** from aeronautical engineer, Lockheed Overseas Corp., Burbank, Calif., to supervisor, engineering shop liaison, Navy Lockheed Service Center, Van Nuys, Calif.; formerly assistant to chief, General Laboratories, Socony-Vacuum Oil Co., Inc., New York City, **P. V. KEYSER, JR.,** is now at the Research and Development Laboratories of the Paulsboro, N. J., branch; **NORRIS BARNARD,** from lubricating engineer of the Colonial Beacon Oil Co., Buffalo, N. Y., to district manager of the Syracuse branch; and **WILLIAM BAUGHMAN** is now an automotive mechanic at Marine Corps Air Station, Pub Works Garage, Majave, Calif.

Also, **VIRGIL C. SPEECE,** White Mo Co., Cleveland, from truck production engineer to executive truck engineer; **WENDELL C. MILLER,** Wright Aeronau Corp., Paterson, N. J., from test engine to senior test engineer; **GEORGE P. BRECOLL,** Packard Motor Co., from design engineer in the Toledo Division to standa engineer for the Aircraft Engine Division Toledo and Detroit; **WILLIAM FISCHER,** North American Aviation, In Dallas, Tex., from assistant group engine in the general powerplant to resident engineering representative at Fairchild Airc Division; **ARMOUR R. HEATH, JR.,** Tr flex, Inc., Newark, N. J., from project engineer to specifications engineer.

Also, **ARCHIBALD M. HALL,** divis manager, Consolidated Vultee Aircraft Co has been transferred from Elizabeth C N. C., to Miami Springs, Fla.; **E. ROBER CARTER,** vice-president in charge of engineering, Fafnir Bearings, Inc., New Brita Conn., has moved to the New York C office; **HOLDRIDGE W. MARSH,** Consolidated Vultee Aircraft Corp., Fort Wor Tex., from tool engineer in the Experimental Division to tool engineer in charge, to design and big fixtures; **JOHN E. McEL ROY, JR.,** Wright Aeronautical Corp., fro field engineer in Los Angeles to assista chief field engineer in Paterson, N. J.

Also, **VICTOR T. KOSS,** Jack & Hein Bedford, Ohio, from draftsman to pro designer; **JOSEPH MASON, JR.,** Curt Wright Corp., Propeller Division, Caldwe N. J., from unit head in the contract de partment to installation coordinator; a **ARNOLD L. ROBB,** Bendix Aviation Cor South Bend, Ind., from junior engineer assistant customer engineer.

Also, **ARTHUR P. SIMONDS,** previous senior test engineer, Wright Aeronauti Corp., Paterson, N. J., is now assistant pr ect engineer; **FRANK M. RULE,** from co sulting engineer, Reynolds Metals Co., Richmond, Va., to plant manager, Sprin field, Mass.; **H. W. TOOMEY** has be transferred from the Miami, Fla., to the R de Janeiro, Brazil, branch of Pan Americ Airways, Inc.; **HAROLD MINGES,** Bu Sulzer Bros. Diesel Engin. Co., St. Lo Mo., from junior designer to design engineer; formerly a technical represen tive of Wright Aeronautical Corp., overse **M. D. MURRAY** is now a field engineer Baltimore, Md.; **MARIO L. LUIGGI** been transferred from the Detroit bra

turn to p. 45

William B. Hurley, staff engineer, Detroit Edison Co., who is one of the many SAE members with sons in the service, is proudly flanked by 21-year old Bob (left), a second lieutenant with the Ninth Army overseas, and Bill (right), a first lieutenant stationed at Camp Croft, S. C.

OBITUARIES

Robert E. Manley

Robert E. Manley, president of Remco Products Corp., died Oct. 22 at the age of 69. Mr. Manley, who graduated from Swarthmore College and obtained his mechanical engineering degree from Stevens Institute of Technology, spent his entire industrial life in Pennsylvania. From draftsman of Seaboard Steel Casting Co. in 1900, Mr. Manley, within a period of 11 years, became president and general manager of United Engine & Mfg. Co., later called Manley Mfg. Co.

He had been an SAE member since 1924.

Clyde E. Bonnett

Clyde E. Bonnett, 62, died Dec. 7. As general manager of Tire & Rim Association, Inc., Mr. Bonnett was responsible for providing detailed annual reports on the number of rims manufactured and inspected. Before joining Tire & Rim, he had been associated with B. F. Goodrich Co. as a tire and tube specialist and took an active part in several of the Glidden Tours.

Richard V. Hicks

Richard V. Hicks, chief engineer of Fram Corp., died recently at the age of 34. While attending the University of Detroit, from which he graduated in 1935, Mr. Hicks was employed in the Chevrolet engine test department. He later joined the engineering staff of Adel Precision Products Corp., and in 1944 went to Fram.

Ugo V. d'Annunzio

Ugo V. d'Annunzio, who was a consulting engineer of American Armament Corp., died Jan. 17. He was 58 years old. A native of Italy, Capt. d'Annunzio came to this country in 1918 to advise the United States Aircraft Board on the construction of multi-motored planes of the Caproni type. He then joined Standard Aircraft and Fisher Body Corp. in consulting capacities, and in 1922 was appointed president of Isotta Motors, Inc., in New York City, representing Isotta Fraschini Automobiles of Milan, Italy.

William F. Krenzke

William F. Krenzke, 59, chief engineer for Jacobsen Mfg. Co., died suddenly Jan. 23. He began his engineering career in 1903 when he designed motors, clutches and other parts for power mowers. In 1905 he became associated with S. Freeman & Sons Mfg. Co., and later joined the engineering departments of Mitchell Motors, Pierce Engine and J. I. Case Co.

Mr. Krenzke, an SAE member since 1916, was actively engaged in SAE Milwaukee Section affairs, and served as program chairman of that Section for 1943-1944.

THE SONIGAGE, A Supersonic Contact Instrument for Thickness Measurement

by
WESLEY S. ERWIN
*Research Laboratories Division
General Motors Corp.*

PRESENTED here is the description of the sonigage, an instrument for rapidly measuring the thickness of metal sections in the approximate range of 0.020 to 0.400 in. with a maximum error of less than 2%.

The simplicity of operation is such that no particular skill is required.

The sonigage has been used to measure the thickness of propeller blade walls, and it should be applicable to other inspection problems where rapid inspection of sections is necessary.

IN the highly stressed parts of modern airplanes the complete inspection of section thickness after final machining is important. This inspection becomes a difficult problem on some finished parts where the inner surface of a wall is not accessible. In some cases, an instrument requiring only external contact to the part is necessary.

The sonigage, which was developed particularly for the inspection of the hollow steel propeller blades made by Aeroproducts, is such a device. High-frequency sound waves, that is, supersonic vibrations, are used by this instrument to determine the thickness of material. With the sonigage it is only necessary to have contact with one surface of the section being measured.

The problem of measuring thickness by surface contact is somewhat similar to that of measuring the depth of the ocean, inasmuch as the ocean bottom is not easily accessible. In 1921 Behm suggested measuring the ocean's depth by sending a supersonic pulse down through the water and measuring the time elapsed until the echo arrived. Since the speed of sound in water is about 4700 fps, the sound would go to the bottom and return in 1 sec when the depth is one-half of 4700 ft. This echo is easily separated from the original pulse until the depth is less than 100 ft, in which case the time interval is only a few hundredths of a second and becomes difficult to measure.

Still shorter intervals are measured with the modern radar equipment which determines distance by the reflection time of a radio wave. Short time intervals are involved because the velocity of such a wave is 186,000 mps and thus even a distance of a few miles is equivalent to only several microseconds. The measurement of such small time intervals involves the use of complicated electronic circuits.

A supersonic wave can be used to measure the thickness of metal parts by the echo method. However, with thin sections the time intervals involved are extremely short. This is due to the high velocity of sound in metals, for example, about 250,000 in. per sec in steel. Therefore, in a piece of steel 1/8 in. thick, the echo will return in about one microsecond. Complicated electronic circuits are also involved in these measurements.

An instrument which would be suitable for routine production inspection should be simple to operate and inexpensive to build. These requirements have led to the development of a different supersonic instrument which

THE AUTHOR: WESLEY S. ERWIN, who graduated from the University of Cincinnati and continued in graduate school there on a cooperative research fellowship from General Motors Corp., has, since 1942, been employed as research engineer in the physics-instrumentation department of the Research Laboratories Division, GMC.

[This paper was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 5, 1944.]

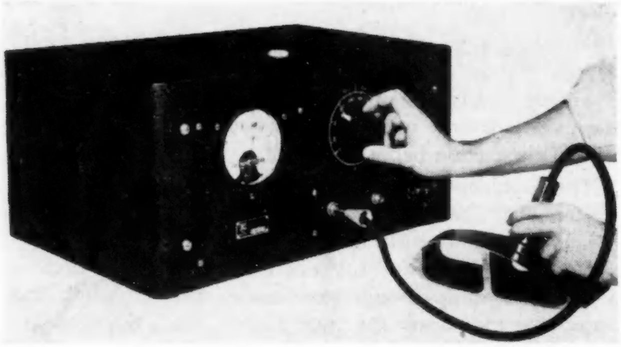
we have called the sonigage.

■ Principle of Operation

The simplicity of the sonigage is due to the fact that it does not measure the time intervals directly but rather the frequency at which the work is set into resonant vibration in the thickness direction. Since this resonant frequency in plates of a given metal is directly related to the thickness, the measurement of frequency determines the thickness.

The sonigage, therefore, consists only of a simple variable-frequency electronic oscillator and a quartz crystal for converting this electrical energy into mechanical vibrations. Their action will be explained in detail later.

Operation of this instrument requires only pressing the quartz crystal into contact with the material and tuning the oscillator dial to the resonant frequency of the work, as shown in Fig. 1. Due to internal damping of the metal, power is required to maintain this resonant thickness vibration. This power is supplied by the oscillator. A power output meter serves to indicate the resonant frequency of the work in much the same way as a "magic eye" on a radio serves to indicate tuning to resonance with a particular station frequency.



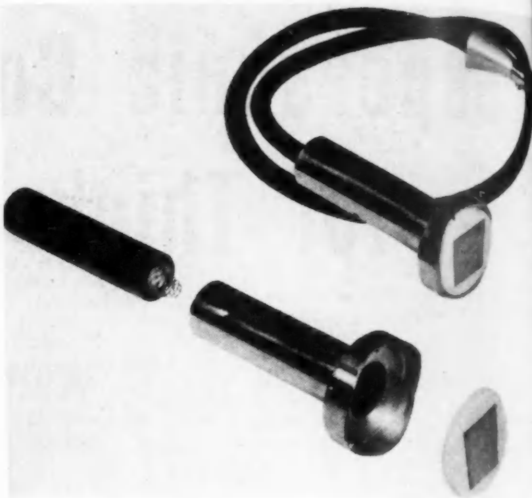
■ Fig. 1 – Using the sonigage to measure the thickness of a metal section

This resonance point is very sharp and if the oscillator is detuned as little as 1% the indicated power amplitude is greatly reduced. Such sharpness makes accurate thickness measurements readily feasible.

■ The Crystal

A small flat piece of X-cut quartz crystal is used in the sonigage. Quartz cut in this manner changes thickness when an electrical potential is applied to its faces. The action is reversible and instantaneous, so that if a high-frequency alternating potential is applied to the quartz plate faces the crystal will change thickness rapidly at that frequency. This forced mechanical vibration can be transmitted to any material by placing one face of the quartz plate in contact with it. Since the amplitude of this high-frequency motion is ordinarily only a few billionths of an inch, good coupling such as that provided by an oil film between the crystal and the work is required. Brushing the work with oil before testing is sufficient.

A typical sonigage crystal holder and cable is shown in Fig. .2 In this unit, the quartz is about one inch square and sixty thousandths of an inch thick. It is silvered on one side to form an electrode and the work serves as the other electrode. The crystal is cemented in a bakelite



■ Fig. 2 – Typical sonigage crystal holder and cable

button which can move up and down between stops in the holder. The holder has tripod feet for stable seating on the work. A coil spring presses down on the silvered crystal face to keep the quartz in contact with the work. This spring also applies the voltage from the shielded cable center conductor to the silvered crystal electrode. The grounded cable shield is connected to the holder and thus, by contact through the tripod feet, the work is grounded.

■ The Oscillator

The oscillator is a simple, one-tube, variable-frequency type, as shown in Fig. 3. Its power output is indicated by a d-c milliammeter in its plate circuit. By using an efficient coil and good insulation the oscillator power losses are kept low so that the normal plate current is small. The variations in this no-load plate current encountered in the oscillator frequency range are compensated by adjusting the special loading plate on the tuning condenser. This small constant plate current is then balanced to zero on the meter by the bridge circuit in which the meter is connected. With this arrangement the meter will read only the additional external power output of the oscillator which is drawn by the crystal when the work is in resonance with the oscillator frequency.

It is perhaps well to point out that quartz crystals have their own natural resonant frequencies which depend on the thickness of the quartz. These fixed frequencies are sometimes used to control fixed frequency oscillators but the sonigage has a variable-frequency oscillator whose frequency is controlled by its coil and tuning condenser. The sonigage oscillator controls the forced vibration of the quartz and the crystals used are always chosen so that their natural resonant frequency is higher than the range used for measurements. Then, even if crystal wear occurred, the quartz thickness would be smaller and its

resonant frequency still higher so that no crystal resonance would be observed.

A single crystal is sensitive over about a two-to-one range of thicknesses, so that sonigage oscillators are built to cover a single two-to-one frequency range. Additional ranges would require changing coils, crystals, and dial scales. Because of the low cost and extra inspection capacity of separate units no such multirange models have been built.

The oscillator tuning condenser dial can be calibrated in frequency but for any one metal it can be calibrated to read thickness directly. This is because the product of the resonant frequency and the thickness will equal one-half the velocity of sound. For any one metal this velocity is a constant and, therefore, the frequency and thickness are inversely proportional.

The Work Vibration

For steel the relation is $f \times t = 125{,}000$ where f is the frequency in kcps, t is the thickness in thousandths of an inch, and 125,000 is one-half the velocity of sound in steel in in. per sec. Fortunately the velocity in steel is not appreciably affected by ordinary alloy content, hardness, or heat-treatment, so one calibration holds for all common steels.

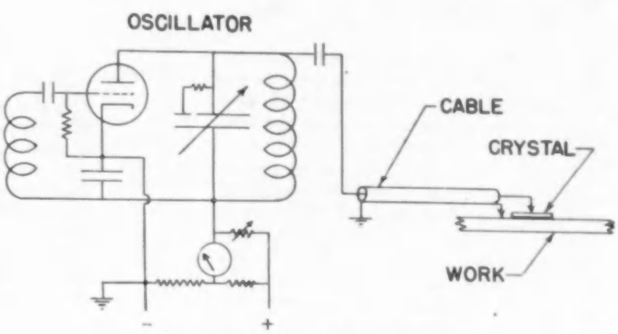
Other metals have different sound velocities and would require different calibrations or the use of conversion factors. A few of the common metals and alloys tested on the sonigage are: steel, aluminum, brass, copper, silver, and stainless steel.

The amplitude of resonance as indicated on the oscillator meter may be less if the crystal has less contact area with the work, due to dirt, lack of oil, or curvature of the work. The indicated peak, however small, will nevertheless still be within the 2% accuracy of the sonigage.

If the crystal is only over a small area of a given thickness, then only a small indication will be obtained but the accuracy of the thickness measurement will be unaffected. If the remainder of the crystal contact area is over another thickness (as on a stepped section) then another indication will be found at that thickness if it is within the range of the instrument.

It is also possible to observe with the sonigage harmonics of the fundamental thickness vibration such as the second, third, and fourth. The indicated resonant amplitudes of such resonance points will be successively smaller than the fundamental indication and this should identify them as such. In the application to the Aeroproducts propeller blade the thickness of the parts before fabrication is known and subsequent operations may decrease but not increase this thickness. In this case sonigages were designed so that the original thickness fell in the thick end of the range. The thickness can, therefore, be measured unless it is about half the original thickness or less, in which case no indication occurs and the part is rejected as undersize.

In the more general case where the thickness of the work is not known, then the harmonic indications may appear on the dial at points which correspond to one-half, one-third, one-fourth, or other fractional parts of the actual



■ Fig. 3 – Sonigage circuit

thickness. For example, in such a case the indication might appear on the dial at 0.070 in. and the actual thickness of the sample might be 0.070 in. (in which case a large meter indication would be obtained), two times 0.070 in. or 0.140 in. (weaker indication), three times 0.070 in. or 0.210 in. (still weaker), and so on. The thickness in this case cannot be less than 0.070 in. or in between 0.070 in., 0.140 in., 0.210 in., and so on. When two or more of such a series of thicknesses are possible the actual thickness still can be determined by the sonigage alone. Two adjacent harmonic dial readings R_1 and R_2 are taken. Since these will be $\frac{1}{n}$ and $\frac{1}{n+1}$ of the total thickness t, then $R_1 = \frac{t}{n}$ and $R_2 = \frac{t}{n+1}$. The solution of these two equations yields $t = \frac{R_1 R_2}{R_1 - R_2}$, or the product of two adjacent readings divided by their difference is the actual thickness.

Conclusion

Briefly, it can be said that the sonigage is an instrument for rapidly measuring the thickness of metal sections in the approximate range 0.020 to 0.400 in. with a maximum error of less than 2%. It requires contact with only one surface of the object being measured. The simplicity of operation is such that no particular skill is required.

It has been used to measure the thickness of propeller blade walls and it should be applicable to other inspection problems where rapid inspection of sections is necessary.

Acknowledgment

The author would like to express his sincere appreciation to Dr. E. J. Martin and Dr. G. M. Rassweiler of the Research Laboratories, for their able direction of the research work on the sonigage; to R. F. Marsh of Aeroproducts Division for his help and patience in applying the instrument to the inspection of propeller blades, and to C. E. Quinn of the Research Laboratories, for excellent construction design.

LEAF SPRING Manual Now Available at SAE

A GUIDE to designers of leaf spring installations, the new "Manual on Design and Application of Leaf Springs," has been published under the authority of the SAE War Engineering Board.

The 89-page booklet contains 44 figures, 4 tables, and numerous detailed calculations, as well as data about materials, their surface finishes and protective coatings, and manufacturing considerations. It is 8½ x 11 in., and bound in a heavy paper cover.

The need of such a manual was expressed some months ago by Col. F. R. Young, Army Ordnance Department, following the publication of the "Manual on the Design and Application of Helical and Spiral Springs for Ordnance," a report made to the Office of the Chief of Ordnance by the SAE War Engineering Board. That report, as well as the current leaf spring manual, was prepared under the direction of the SAE W.E.B. Spring Committee, of which Tore Franzen, Chrysler Corp., is chairman. The Leaf Spring Subcommittee was composed of 16 engineers, representing leading vehicle manufacturing companies and spring suppliers, and had the benefit of 7 officers and civilian engineers and specialists as Army consultants.

Following the introduction and discussion of general characteristics of leaf springs, three pages are devoted to nomenclature and specifications, and five pages devoted to requirements drawings and specifications. The third chapter is on Design Elements, and the fourth is on Design Calculations.

Basic considerations of interleaf friction are included, and a chapter relates to materials, cold finishing, finishes, and protective coatings. The book closes with a chapter on flat springs.

Copies are available to SAE Members for $1, and to non-members for $2, postpaid, from Special Publications Department, Society of Automotive Engineers, 29 West 39th St., New York 18, N. Y.

Dayton Section Renamed

SAE Southern Ohio Section has been granted Council approval to be known officially as the SAE Dayton Section, the change to become effective June 1, at the start of the 1945-1946 Section year. Formation of the SAE Cincinnati Section necessitated this action, as the name "Southern Ohio" was an incorrect designation of the Section territory.

Student Enrollment Up

SAE student enrollment has met the impact of another war year with increased representation from schools and other institutions where membership had previously been light or non-existent – rallying, in this way, from the severe cut it might otherwise have suffered from decreasing numbers of civilian students and curtailment of military training programs in engineering colleges.

Total SAE enrollment as of Dec. 31, 1944, was 552, with 406 enrolled students attending 33 engineering schools and colleges; 83 completing their membership in the armed forces; and 63 in industry. Although

Rambling Throug

STAR of **CHICAGO SECTION'S** Navy Night Program Jan. 30 was George Bernasek, a U. S. Navy torpedo-man, whose dramatic account of his survival of a submarine disaster off Casablanca was an experience vicariously shared by all his listeners . . . Action-packed United States fighting film "We Said We'd Come Back" heightened evening's thrills, although a lighter side was later provided by the music and entertainment of Billy Walsh's orchestra . . . Tractor and Industrial Power Meeting held Feb. 13 with John I. Yellott, director, Institute of Gas Development, Illinois Institute of Technology, discussing turbine superchargers, jet propulsion and robot bomb development, as well as the European war use of jet propulsion planes . . .

SAE President J. M. Crawford discussed Engineering Management at the Dec. 14 meeting of **WESTERN MICHIGAN SECTION** . . . Accompanying his talk with slides, Mr. Crawford indicated that one of his first tasks upon coming to Chevrolet was to set up very simple but important organization charts . . . These charts, which have grown considerably, he stated, are evidence that the organization now rates as one of the largest engineering companies in the country . . .

Low-down on the diesel engine was the subject of University of Michigan Prof. E. T. Vincent's talk at Jan. 18 meeting of same Section . . . Fundamental require-

SAE President J. M. Crawford (left), discussing with Chairman Earl Ginn some of the points of engineering management, the subject on which he spoke at the Dec. 14 Western Michigan Section meeting

ments of the diesel, he stated, are: (1) heat must be retained in engine cylinders and the more heat the better for power development; and (2) combustion of the fuel must be completed as near the top of the stroke as possible, so that the expansion ratio will be a maximum . . . Predominating types of combustion chambers, which he illustrated with slides, are, he said, open-type chamber having a degree of turbulence for mixing fuel with air; turbulent-type chamber; energy cell; and pre-combustion type . . . Regarding injection pumps, Prof. Vincent favored one that injects at an initially high pressure, rapidly tapering off to low pressure so as to give a long injection time for a given quantity of fuel . . .

More than 350 members and guests turned out for the Feb. 1 Transportation & Maintenance Meeting of **METROPOLITAN SECTION,** when a symposium on cold starting was presented by a trio of Philadelphia engineers under the chairmanship of T. A. "Ted" Drescher, Met. Section T&M vice-chairman . . . Lead-off man was Emil P. Gohn, new SAE T&M vice-president, Atlantic Refining Co., who was followed by H. C. Riggs, Electric Storage Battery Co., and Herbert Dalgleish, Philadelphia Transit Co. . . .Reports on immersion heating of engine water jackets, heated batteries, and heating engines in buses parked out-of-doors by infra-red lamps, were presented and discussed . . .

Turkey draw among 100 members and guests of **CANADIAN SECTION** Dec. 20 realized over $100 for the V-bomb war victims' fund . . . Section Vice-Chairman George J. Beattie pinch-hit for Chairman W. A. Wecker at same session, where J. C. Cooper, assistant manager of the Radio Division, Canadian General Electric Co., addressed the audience on "Electronics: A New Science for a New World" . . . traced electronics developments from the "Edison effect" through radar and new safety improvements in navigation and flying to dipping into the future when the successors to V-1 and V-2 may be given pin-point accuracy and long range . . .

Gathering of 55 at **NORTHERN CALIFORNIA SECTION** meeting Jan. 23 heard Lewis A. Rodert's paper on trends in ice-prevention technique presented by his understudy, Alun R. Jones, Ames Aeronautical Laboratory, National Advisory

Section Reports

Committee for Aeronautics . . . Mr. Rodert, who is head of the flight engineering section at the laboratory, wrote that thermal de-icing by means of combustion heaters and hot air ducts appears to be the most promising method of ice-prevention, and many transport ships have been successfully equipped with thermal de-icing units . . .

Personal experiences in China-India-Burma Theater, where he served four and a half years, were related to same group by Major L. S. Sherry, who retired shortly after the fall of Singapore . . . Major Sherry's first-hand account of the war in China; his own role in it when he commanded a Chinese army of 70,000 men with weapons for about 5000 and stayed with his group while retreating 3000 miles until the number eventually dwindled to 5000, was a stirring message to everyone to cooperate in the all-out war effort . . .

Recommended practices for winter operation of automotive equipment were made by R. Wayne Goodale, California Research Corp., at **SALT LAKE GROUP'S** Jan. 8 meeting, and included the following suggestions . . . properly maintain thermostats; install high-temperature thermostats; install baffles to prevent cold air from circulating around the intake manifold, crankcase and valve compartment covers; use radiator covers where practical; increase manifold heat; use insulation materials on exposed parts; reduce idling to a minimum; and use compounded lubricating oils to lessen the adverse effects resulting from the use of fuels of present quality.

Novelty was incorporated into **SOUTHERN CALIFORNIA SECTION'S** Air Transportation Dinner Meeting Jan. 11 with a half-hour's broadcast via the National Broadcasting Red Network, Station KFI, Los Angeles, of the first part of the session . . . Sponsored by the Public Service Division of NBC, the broadcast gave Section Chairman George Tharratt an opportunity to expound in detail for the laymen's benefit the activities of the SAE . . . Timely and interesting discussion was then presented by Robert L. Smith, executive vice-president of the Los Angeles Daily News, president of Mission Nurseries, Inc., and president of the Los Angeles Airport Commission, whose contact with aviation from the service and customer angles gives him an authoritative insight into the troubles and conveniences of air transportation . . . He stressed the point that the SAE, which is a shining example of the technician who does the greatest work to benefit the nation as a whole and gets minimum credit, needs an active advertising agent to supplement its already extremely active technical experts so that the Society can procure its due share of acclaim . . .

Evening's second speaker, W. F. Carroll, in charge of airports for the Civil Aeronautics Administration, Western region, reported on Government incentives and controls for the development of airports throughout the nation . . .

Joint meeting of American Society of Tool Engineers and **SOUTHERN OHIO SECTION** Jan. 8 drew an attendance of 150 persons, 90 of whom came for dinner . . . Fred B. Lautzenhiser, International Harvester Co., did the honors for the SAE in a non-technical discussion of diesel versus gasoline powerplants in motor trucks, while Howard L. Pope, service manager, Cincinnati Milling Machine Co., represented the ASTE with his paper on high-speed milling . . . Two reels of high-speed movies illustrated the latter presentation, showing the different tool contours used in the type of milling described . . .

SYRACUSE SECTION members gathered around their own fireplaces Feb. 5 when a coal emergency ruling made it necessary to cancel their scheduled meeting of that date . . . Plans included a dinner at the University Club and a talk later by C. J. Hamlin, Jr. and A. M. Young, Bell Aircraft Corp., on the subject of Helicopters . . . As a substitute a spur-of-the-moment dinner meeting was held for Feb. 23 which was followed by informal after-dinner talks and a few reels of motion pictures . . . Attractive dinner menu and program cards already prepared for the Feb. 5 meeting were sent to members to show them what they missed . . . among other things roast beef . . .

Crystal-gazing into the future of aviation, J. S. J. Hlobil, former president of Columbia Aircraft Co., foresaw at **OREGON SECTION** meeting Dec. 9 that the expected glut of military aircraft on the market after the war would not be realized provided large quantities will be released for civilian use immediately the war ends . . . He reasoned that since military aircraft are not suitable for civilian use either in the handling of passengers or of cargo, and since they are inefficient in handling load-carrying capacity, they would not be economical to operate under normal conditions of competition . . .

Merry-making among Sectionites was quite in order Dec. 14 when a dinner dance, under the chairmanship of J. Verne Savage, was held at Oswego Country Club . . .

Gasoline (100-octane variety) will be as scarce after the war as cigarettes are now, according to R. J. S. Pigott, Gulf Research & Development Corp., who

concluded on page 47

this number is 21% less than the 703 SAE students enrolled on Dec. 31, 1943, the extension of the SAE student program found on many campuses is an encouraging note. An outstanding example of this is in the University of Minnesota, where SAE faculty members' cooperation with the SAE Twin City Group resulted in enrollment of 20 students between Oct. 1 and the end of the year.

Further evidence of the interest of SAE Sections and Groups in engineering college SAE organizations is manifest in the aid given Student Branches and Clubs by the Section and Group committees in planning programs, securing speakers, and being made welcome at Section and Group meetings.

SAE student organizations which were still operating strongly at the close of 1944 were at California Institute of Technology, Case School of Applied Science, College of the City of New York, Detroit Institute of Technology, Fenn College, General Motors Institute, Ohio State University, Purdue University, University of Detroit, and the University of Wisconsin.

Talks at Stevens

ALLEN PRICE, Platt-LePage Aircraft Co., described and explained the construction of the Platt-LePage helicopter before a student group at Stevens Institute, Hoboken, N. J., the evening of Jan. 17.

Mr. Price was introduced by J. I. Hamilton, vice-chairman of the SAE Metropolitan Section for student activities.

Stressing both the basic limitations and inherent advantages of the helicopter, Mr. Price examined the craft's probable post-war applications. He discounted the likelihood of its early use as a family vehicle, pointing instead to its adaption to commercial usage for short-haul ferrying operations.

Mr. Price illustrated the helicopter's performance with colored motion picture studies of the aircraft in action.

The ASME Student Branch of Stevens Institute was host to the meeting, which was attended by SAE and ASME students from various engineering colleges in the New York City area.

Student Branches Active

THE Caltech Student Branch featured the display and discussion of electrical aircraft accessories by A. W. Atwood, Lear Avia of California, at its meeting of Jan. 25. Electrical actuators are a development brought about by the war, Mr. Atwood declared, because they proved less vulnerable than hydraulic units in all but the largest sizes. Mechanical engineering instructor Peter Kyropoulos is the new faculty adviser for the Caltech Branch, succeeding Dr. A. L. Klein as counsel to the student organization.

New officers were elected at the Jan. 18 meeting of the Purdue University Student Branch. William Meyer now holds office as chairman, with Stephen Jack vice-chairman, and R. B. Shumaker secretary-treasurer.

In its Jan. 23 joint meeting with the ASME Branch, the University of Wisconsin Student Branch attended an illustrated discussion of balancing machines by W. I. Senger, Gisholt Machine Co. Mr. Senger described simple and special purpose balancing machines, and explained the operation of correction machinery.

SAE Group Studies Army Mud Test Project

EXTENSIVE test work was reported and detailed plans were laid for future procedures when the SAE Tractor War Emergency Committee's Mud Testing of Military Vehicle Committee met for three days in January at Aberdeen Proving Ground. Preliminary reports of the committee have been received by Col. G. C. Eddy, director, Ordnance Research & Development Center, for study by Army officers.

In an expression of appreciation for the committee's work, Army officers pointed out that motorized warfare is elevating flotation and traction to major factors in military strategy, transforming ground pressures into pertinent features of equipment, making soil testing as essential as scouting.

Basically, the committee's current job is to help the military decide when, how, and where the motorized equipment of the United Nations may conquer Western Europe's boggy terrain. This major objective is attended by satellites demanding engineering techniques.

The satellites include such jobs as enabling the military to maintain a war of mobility, and of moving men and materiel about a continent marked by irreparably complete destruction of its transportation system. They comprehend also such down-to-earth engineering jobs as making it possible for military vehicles to operate in a land covered by deep layers of slippery, tenacious, seemingly bottomless sands, silts, and clays frequently more effective than the enemy. Also, they anticipate the probable future use of heavier equipment.

These objectives are being approached through the proposed construction and operation by Ordnance at Aberdeen of extensive mud testing laboratory equipment. It would be designed, developed, and used with the aid of the SAE committee, and operations would be coordinated with rigid field tests. L. S. Pfost is committee sponsor, and Emil F. Norelius its chairman. Also working on the project are American and British Ordnance officers and soil experts.

The project contemplates establishing, by laboratory methods coordinated with field tests, data on uniform soil conditions, soil constants, reliable methods of soil testing and grading, and other information of practical application. End results include design and construction details of a relatively few tracks which will assure effective flotation and traction for military vehicles in any of the world's four or five basic soils. Byproduct results, themselves of no limited importance, are seen as development of portable soil-testing instruments for field use and ultimate preparation of "vehicle going maps" to give strategists advance information as to where – and which – vehicles may be employed for combat and service purposes.

Tentative plans provide for the erection at Aberdeen of a controlled soil testing laboratory 800 ft long and 265 ft wide, housing five soil bins. In these bins, each 600 ft long, 30 ft wide, and 10 ft deep, vehicles would be test operated under conditions permitting complete instrumentation. Moisture content, temperature, and other soil characteristics would be controlled. An 80-ft traveling crane would place, transfer, or remove test vehicles, however deeply bogged.

A second building would house soil storage bins, model testing room, soil physics-chemistry laboratory, and office. A third structure would comprise electric boiler and power house. The testing plant would be the largest ever built and would provide test facilities more adequate than were available in the smaller, shallower agricultural test bins used in preliminary test operations at Alabama Polytechnic Institute.

Operations largely would follow the mountain to Mohammed plan. Soils representative of the world's basic types would be transported to Aberdeen in trainload lots and there be prepared, mixed, or treated to simulate extreme field conditions. Among them would be the sticky Lufkin forest soil from Alabama and the Wilson prairie soil from Texas; the Cecil clay of Charlottesville, Va., and the Davidson; and the so-called "bottomless" silts – the Clermont from the Ohio River uplands and the Waverly from Marks, Miss.

Preliminary consideration of the problem by the committee has indicated interest in obtaining the highest possible efficiency in the fields both of flotation and of traction and ultimately of developing tractive effectiveness regardless of soil conditions. Higher importance is given to flotation, with emphasis upon establishing ground pressure limits; upon the track length versus width; and upon continuity of support, or number of supporting wheels. In the case of traction, concern has been shown for type and shape of shoe sections, shape of lugs or grousers, and closed or skeleton type shoes.

Major interest has been directed to establishing "soil factor numbers" and to the development of soil-testing instruments useful in preparing "vehicle going maps." Consideration would be given to available British instruments, such as the "Campbell Bog Stick," now regarded as essential military field equipment and used to survey the bearing properties of soft ground and to plan a safe route through doubtful terrain, and the "Hoad Penetrometer," which is viewed as more accurate but too heavy for field use.

In its work the American committee expects to have the benefit of findings of the British Committee on Mud Crossing which, in cooperation with Army, agricultural, and road research organizations, has done considerable work in advance testing of soils, in predicting soil conditions, and, particularly, in developing "vehicle going maps" which reveal expected soil conditions in relation to vehicle operating in any desired district five days in advance. The British group, apparently with conditions in Belgium and The Netherlands in mind, has concentrated on mapping and testing soils adjacent to river estuaries and along low-lying coasts, where operation of track-laying vehicles becomes difficult.

Army technicians have indicated they are thinking in terms of three types of tracks – rubber for hard roads and desert use, steel chevron tracks for mud, and rubber blocks with detachable grousers for maximum conditions and combat operations. Members of the committee have pointed out, however, that operation of the test should establish which track types are preferable.

SAE TWEC Mud Testing Committee members who met with U. S. and British Army officers Jan. 16 – 18 included, left to right, back row: F. A. Kummer, Alabama Polytechnic Institute; Paul Huber, General Motors Proving Ground; R. C. Sackett, Society of Automotive Engineers; L. C. Daniels, Oliver Corp.; Brigadier G. M. Ross and L. E. Carr, both of the British Army staff. Second row: Major R. H. Clark, APG; Lt.-Col. E. Gray, APG; W. E. Zierer, Chrysler Corp.; E. F. Norelius, Allis-Chalmers Mfg. Co.; Col. G. G. Eddy, APG; Maurice Olley, British Army staff; M. S. Nichols, U. S. Department of Agriculture; Major C. S. McKenzie and A. D. Elliot, APG. Front row: Lt. Hetzel, APG; Lt. P. W. Hemmiley, APG; R. C. Williams, Caterpillar Tractor Co.; E. W. Stein, Firestone Tire & Rubber Co.; F. L. Haushalter, Office of the Chief of Ordnance-Detroit, and Lt. J. S. Lobb, APG

Post-War Car Surveys

INTENSIFIED public interest in the results of the automobile surveys conducted by the *San Francisco Examiner* and the *Chicago Herald-American* for presentation at the Passenger-Car Body Session of the SAE War Engineering Annual Meeting Jan. 8, has led each of these newspapers to publish separately a book containing this information.

Readers of the *SAE Journal* may receive these books free of charge by writing to F. C. Wheeler of the *Examiner* and Herbert D. Wilson, automobile editor, *Herald-American*.

Technical IDEAS for ENGINEERS

Briefed from Papers Given at SAE Meetings

Gasoline Solid Injection Opens Way to 2-Stroke Developments

by H. O. HILL
American Bosch Corp.
• 1944 National Tractor Meeting

(Excerpts from paper entitled "The Application of Gasoline Injection to Tractor Engines")

VARIOUS engine applications demand different load curves of an engine. Tractor engine requirements, however, embrace all the characteristic curves of all other applications and demand complete coverage of all the area enveloped by the limiting curves.

In the case of the tractor, automatic compensation for atmospheric density does not have to be provided, and tractor execution might get by with a manual control or adjustment to take care of seasonal change or change of locality.

Three principal basic types of master mixture control are:

1. Mass air flow control, which appears to offer the most comprehensive fulfillment of requirements, but which is costly, bulky, and sensitive, and not attractive for tractor applications.

2. Manifold pressure control, which is favorable on account of its small size and simplicity. If rapid changes of temperature or barometric pressure are not to be dealt with, this control should do an adequate job.

3. Straight mechanical control, which is probably the most rugged, least bulky, and cheapest, but which introduces some compromise with the ideal mixture ratios.

Fig. 1 shows three curves relevant to the volumetric efficiency of an engine. The first shows how a high manifold pressure raises volumetric efficiency. The second indicates how low intake temperature reduces volumetric efficiency. The third illustrates the benefit derived from a large intake manifold.

There are two basic alternatives at the business end of the system, which is the gasoline spray: 1. The nozzle may be located in the intake pipe just behind the inlet valve (simpler to install in existing engine designs); 2. The nozzle may be located in the cylinder head itself, so that the spray enters directly into the combustion chamber (the most benefit from the gasoline injection system can be achieved this way).

Objections to Gasoline Injection

Gasoline injection systems are considerably more costly than the carburetors they would replace. Unless special preventive measures are taken before a tractor is laid up for the season, deterioration in storage is likely to be severe; much more so than in the case of a diesel engine. This system is also inherently sensitive to foreign matter and requires a high-grade fuel filter which must be properly maintained.

One of the greatest disadvantages of gasoline injection for application to tractor engines is that it uses gasoline. In many contracting jobs, a large percentage of gasoline for gasoline tractor engines is used for automobile rather than tractor tanks – while diesel or distillate fuel will not operate in an automobile engine.

Advantages of Gasoline Injection

The injection system gives a material improvement in fuel economy as compared with the carburetor job. With direct injection into the cylinder, there is complete separation of the functions of fuel admission and air admission, with the result that the engine designer is free to select a valve timing favorable to thorough scavenging. The fact that the ingoing air does not have to be heated allows a higher density in the cylinder, and this makes possible higher output.

Since no fuel is carried through the intake manifold, it is not necessary to maintain a high manifold velocity in order to avoid precipitation of the fuel, and the low manifold velocity which is tolerated by the injection system gives a considerable increase in volumetric efficiency at the higher engine speeds.

Gasoline injection materially improves the low-speed torque of the engine – important in tractor service. Also, with no fuel in the induction system there is no possibility of backfiring, and this reduces the fire hazard.

Vapor lock can be eliminated because the fuel supply pressures to the injection pump can be much higher than those used with carburetors.

Cold starting is excellent, and cylinder liner wear due to cutting of the lubricating oil with liquid gasoline should be consider-

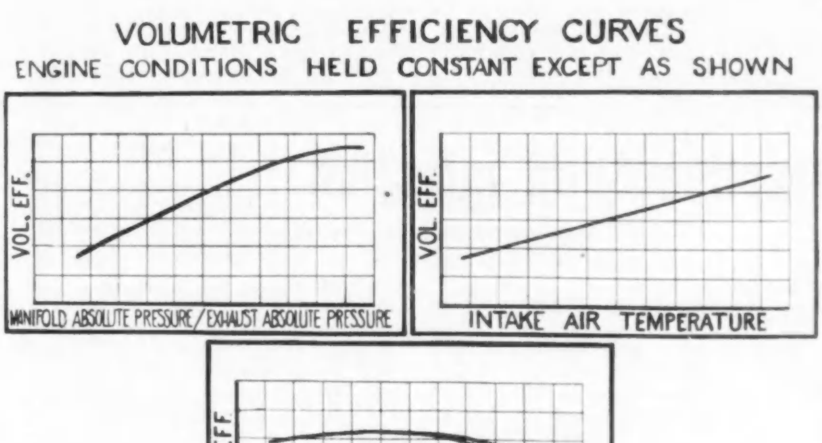


Fig. 1 – Three curves relevant to the volumetric efficiency of an engine

Pre-war and Current Standards Are Basis for Intensified Work

by J. H. HUNT
General Motors Corp.

▪ 1945 War Engineering–Annual Meeting

(*Excerpts from paper entitled "The Future of SAE Automobile Standards"*)

SAE standards activities affecting automobiles will be considerably increased in the early post-war period, but will follow the same general lines as at present. When stable conditions finally do appear, many revisions of present standards will, however, be necessary. The overall result will be that both of the pre-war types of standardization will be more active than before. These include:

1. Study and progressive revision of existing standards to meet improved practices better adapted to changing conditions.

2. Development of new standards as new materials, processes or practices are found to be generally useful.

SAE standards activity will continue to follow the two methods used now. One involves the SAE alone, which is in a position to revise as seems desirable without formally consulting any other organization. The other method involves cooperation with other standardizing bodies usually under American Standards Association procedure.

Present Organization

Standards work is under the supervision of the General Standards Committee concerned with general policy rather than actual development of standards. This committee transmits approved reports to the Council for its approval, after which they are inserted in the Handbook. Development work is done in 18 divisions, chairmen of which constitute the personnel of the general committee. The divisions carry out part of their work in subdivisions, some of which are temporary, some permanent.

Only the engineers active in a given field have the information needed for developing standards. They do not have the time for the tedious, detailed secretarial work essential to success. This staff job is not one for amateurs. The very great contribution to SAE standards by the staff can only be appreciated by persons active in standards division work.

Uniformity of design and practice throughout all American industry would be highly advantageous in the case of a generally used machine element such as a screw thread. An SAE standard is good, but an American standard would be better for the automobile industry if this standard included the features essential to the automobile.

Increased use by other industries of materials and processes first developed for the automobile industry will cause these industries to wish to have a voice in drafting the standards which affect these materials and processes. Thus, there is expected to be an increase in the number of subjects which will be handled by SAE and others under ASA procedure. Such cooperation is indicated as long as the overall result is better economy and the automobile industry receives a benefit from this.

Aeronautics Division

This division has been exceedingly active during the war years, and under the direction of Chairman Arthur Nutt, it has made most important contributions to the national war effort in aviation. If the automobile industry is to do its best in any later emergency, it must maintain proper contact with these developments. Therefore, the SAE should continue in its present activity in aeronautical standardization, even if automobile production activity in aviation goes back to substantially the pre-war basis.

Where only one other standardizing body is involved, it is sometimes simpler for the SAE to work directly with the other organization, either by means of SAE representation on committees of the other body, or through the operation of a joint committee. There is a long history of such cooperation with the American Society for Testing Materials, to which the SAE looks for specifications for test methods. The SAE has representation on nine ASTM committees.

Iron and Steel Division

This division has been reorganized to deal with added wartime work. The automobile industry provides the greatest market for high-quality steels. Continued cooperation between the steel and automobile industries is to be expected in developing improved practices. The organization of the new I & S Division panels with representation from both industries provides a more effective way of dealing with the problems expected to arise.

Although SAE standards are developed for voluntary use on the basis of experience, on rare occasions conditions occur when SAE cannot handle all of the problems. If it becomes necessary to secure agreement from manufacturers to use some standard which must be developed by new experimental work, then a special organization becomes necessary. The Sealed Beam Headlamp program is an example.

There is considerable activity in promotion of the development and greater use of consumer standards. While the drive, in general, has been for standards for foods, clothing materials and other articles distant from automobile activity, there has been some discussion of the desirability of developing standards for repair parts. If standards were available, parts complying to the standards could be labeled, assuring the consumer that they were functionally adequate.

It seems desirable for the SAE to supply engineering information and to cooperate in other ways with organizations working on such standards with the idea of improving the general situation.

The value of standards can best be illustrated by mention of some standards which are already desirable, but are not yet available.

Extensive use will be made of synthetic rubbers, because they are already known to be superior to the natural product for certain purposes. Tests on physical properties of the end product are the basis of most rubber standards now available to the automotive industry.

Great advances in the fatigue life of highly-stressed machine elements have been made possible by processes of prestressing in compression the surface layers at critical points. Shot-peening is one of these processes. Application of these processes is handicapped by the lack of any standard test which could be used for the determination of the surface layer stresses.

A great impetus could be given to engine development if the engine designer could today know what the standard properties of the 1950 fuel will be.

In the future there will probably be more cooperative effort on automobile standards than in pre-war days, but the industry will continue to need its own standardizing body. The SAE for this purpose is well adapted to the requirements.

Gasoline Solid Injection

continued from preceding page

ably less than in the case of the carburetor engine which is started by choking or priming.

Lower grade fuels may be employed when direct-to-cylinder injection is used, because of the mechanical atomization by the nozzle, and because the timing of fuel admission can be adjusted suitably without impairment of engine breathing functions.

Full advantage can be taken of superchargers, whether the nozzle is situated in the cylinder head or behind the inlet valve, because in either case injection can be withheld until the beneficial influence which supercharging exercises upon scavenging has been realized.

Gasoline injection spark-ignition engines score heavily over diesel engines in the matter of cold starting, and in the case of small engines, in the matter of hand starting. They are also less expensive than diesel engines.

Many existing engines may be readily modified to accommodate spray nozzles in the cylinder heads and an injection pump drive. Entirely new engine designs, laid out in the first place for gasoline injection equipment, may be designed with appropriate inlet and exhaust manifolding and porting, and may be endowed with valve timing.

Gasoline injection opens the door wide to the two-stroke-cycle gasoline engine, for tractor application, and the economies which are inherent in the two-stroke engine might do more than offset the cost differential between gasoline injection equipment and the carburetor.

Nazi V-Bombs Are Equipped with Pipe Organ Engines, Radio Sets

by G. GEOFFREY SMITH
Managing Editor, Flight

Detroit Section, Dec. 4

xcerpts from paper entitled "Crewless Craft")

EFORE discussing the main features of the V-1 bombs, Germany's first secret eapon, I should like to describe one of the ser known of the Nazi's reaction-propelled ing bombs – the Hs 293, built by the Hen-el Co. Carried usually under the wings such types as the He 177, the Do 217E, the Fw 200, the bomb is radio-controlled, cket-propelled, and used mainly against ipping.

It is composed of a relatively small fuse-ge which carries a pair of wings, tail sur-ces and vertical fins, a tail tracer unit and rocket-propulsion unit. The forward part the fuselage is the bomb body (total eight about 1300 lb) while the rear sec-on houses the radio-controlled automatic lot and its control unit.

When released from the parent aircraft, peration of the propulsion unit and the acer unit is initiated and the bomb fuse is med. After launching, it is immediately ought under radio control from the parent rcraft, which is effective over a range of out five miles.

The Hs 293, which has an overall length f 12 ft 4 in. and a span of 10 ft 3 in., is id to be reasonably maneuverable with a eight that can be maintained and cor-ected. With a total weight of 2000 lb, the aximum speed is reported to be about 300 mph.

The V-1 rocket bomb is that ingenious issile used for indiscriminate bombing of ondon and the southern counties of ngland. It has no blower or turbine to ompress the air. The propulsive unit is simple tube of 11.25 ft and 1.9 ft diam-ter, its only working parts a series of small ring steel shutters arranged in pairs like V inside the grille at the front. In the rille are nine fuel jets, equally spaced in ree layers between horizontal venturis.

There is a plug to start combustion. When fficient air pressure has been obtained by orward speed, the valves open and admit e air to mix with the gasoline to maintain mbustion. The frequency of explosions about 45 per sec; that is, 2700 per min, he sequence being maintained by the esidual flame left in the combustion hamber.

Before the engine unit can propel the inged bomb weighing 1870 lb, it is neces-ary for it to be moving forward at con-iderable speed to insure sufficient air pres-ure to force the valves open. It will stall t 150 mph, for example, but will carry on f projected at about 200 mph. Thus, ssisted takeoff is necessary, although the ngine is first started up on the ramp of he launching platform. Once sufficient peed and air pressure has forced the valves pen to enable air to mix with the fuel, the ressure in the combustion chamber rises nd exerts equal forces in all directions.

Burning gas escapes rearwards at high elocity through the reduced diameter exit t the tail, and the force of ejecting the apidly expanding gases exerts an equal and opposite force on the V-type shutters of the grille. The depression which is created behind the grille as the burning gases emerge from the tube enables the valves to open again by the outside pressure of air, and this action is continuously repeated, the flying bomb accelerating meanwhile to its maximum speed of about 400 mph. At 360 mph the thrust is 600 lb or 575 thrust hp.

This is a crude pipe organ engine, for its valves tend to burn and break at the end of the journey, when the whole contrivance is blown to pieces. Fuel consumption is nearly a gallon a mile, for 130 gallons are carried for its range of 150 miles. To absorb vibration, the engine is mounted on rubber at three points.

Fuel is fed to the nine jets by two 22 in. diameter compressed air bottles in the fuselage. They are wire bound over a shell of welded mild steel. At a pressure of 150

atmospheres the air not only forces gasoline to the engine, but also spins the gyroscopes in the automatic pilot and operates the pneumatic servos to the rudder and elevators. The range is controlled by a windmill in the nose which operates a Veedertype counter. As the counter gradually returns to zero, two electrically-fired detonators in the tail of the fuselage are discharged to force down spoiler flaps on the tailplane and sever the controlling tubes of the rudder servo, to put the machine into a dive.

When the flying bomb strikes the ground, its warhead of nearly a ton is detonated. Normally the robot bomb used to come over the English coast at about 2000 ft in level flight, but if conditions were cloudy, in order to escape the vigil of Allied fighters and gunners, the controls could be adjusted at the start to give up to 5000 ft altitude. About one in ten machines had a radio set to transmit a constant pitch note recording distance and direction.

The V-1 has the following dimensions: Overall length, 25.375 ft; length of fuselage, 21.5 ft; length of power unit, 11.25 ft; maximum diameter of power unit, 1.9 ft; wingspan, 17.67 ft; wing area, 51 sq ft; wing loading, 93 lb sq ft; and all-up weight, 4750 lb.

Precision Essential In Small Test-Engines

by NORMAN C. PENFOLD
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■ 1944 National Fuels & Lubricants Meeting

(*Excerpts from paper entitled "Some Comments on Engine Testing of Heavy-Duty Oils"*)

THE increased growth of the engine as a laboratory tool for the purpose of rating lubricating oils has been generally due to one, or a combination of the following causes:

1. The recognition that the performance of lubricants of different origin was widely variant as indicated by differences in field experience on engines, although lubricants may have been equally satisfactory for other uses.

2. Lack of information regarding physical and chemical changes taking place in a lubricant when subjected to the contaminating action, thermal and oxidizing stresses and catalytic effect present in an internal-combustion engine.

3. Deficiency of information regarding internal-combustion engines, such as temperatures prevailing at vital places in lubricating oil circuits.

4. Increased application of internal-combustion engines, and keen competition between engine manufacturers which made it necessary that the user be assured the engine would not give unsatisfactory performance because the lubricant was unsuitable.

5. Deficiency of information regarding effects of atmospheric conditions, engine load and speed, fuel characteristics and other operating variables.

6. Failure of numerous chemical and physical bench-type tests to provide lubricating oil evaluation data correlating with that obtained in engines in service.

7. Difficulties experienced in applying information obtained in more scientific approaches, such as investigations on an oil involving x-ray diffraction, spectrograph, and so forth.

8. Unsatisfactory results obtained from field tests because of difficulty experienced in controlling the factors affecting the lubricant.

Endurance Tests Used

The most popular operating procedure of Caterpillar Tractor Co. – now incorporated in CRC designation L-1-1143 and used in U. S. Army specification 2-104B qualification – requires 480 hr of operation, and is generally thought of as an "endurance" test. No attempt is made to accelerate oil deterioration. Based on the judgment of competent observers, service performance of oil is predicted in terms of possibly 6000 hr of engine operation with normal oil change periods. Attempts have been made to shorten

st duration to increase its usefulness engineering research involving large nbers of base stock and additive comations.

rvice difficulties in automotive-type entraceable to lubricant differences were ponsible for the selection of the Chevromotor car engine as an oil evaluation aratus. Various operating procedures e investigated and those outlined in C designation L-4-1143 have been used widely. The low first cost of the ine and necessary complementary equipnt and the short test duration recommend for laboratory use.

Foremost of the two-stroke cycle diesel ines used for lubricant evaluation work the General Motors "Series 71" engine the 1, 3, 4, or 6-cyl models.

CRC designation test L-5-1143 is written und the 3, 4, and 6-cyl models of these ines and is also a part of the Ordnance lification schedule. Operating on the o-stroke cycle with uniflow scavenging d direct injection, certain lubricant facs may be evaluated which are not comn to other tests.

Small-scale engines, notably the Lauson d Delco gasoline engines, have generally n used to expedite oil testing or develment programs and are used in so-called ch screen or pre-evaluation tests. Where e numbers of oil are to be investigated, all-scale engines are particularly valuable.

At this time oils for heavy-duty service st be evaluated by competent observers ose judgment of mass evidence from merous engine tests serves as the basis r that evaluation.

No presently known bench-type tests, her chemical, physical or a combination both, are adequate to evaluate oils for avy-duty service. These tests can serve supplement engine test data, be used as e-evaluation tests, or as research tools.

Care should be taken to avoid the deopment of lubricants to pass arbitrary ts or the development of such tests to or certain oils.

Engine tests must continue in use for ting, development, and research on addies and oils whether they be for pourint depression, corrosion prevention, atch resistance, and so forth.

Accelerated-type engine tests are convennt laboratory evaluation means, but the ults obtained should be carefully weighed prevent a distorted judgment of the sere value of the oil.

Field performance must always be used the final evaluation since engines may be d and worn, in severe need of mechanical ntion, and be operated on poor fuels der difficult atmospheric conditions.

In order that test engines may satisfy the mediate requirements of evaluation proams and yet contribute basic data so luable in long-range research programs, has been suggested that bench-type tests developed and made in conjunction with e engine tests.

Small scale test engines should be conucted to precision standards comparable th the full-scale units to make preliminary screen tests of more certain value. Accy in evaluation and reproducibility of ults should be the first consideration in e selection of any such equipment.

CHROMIUM PLATING RECOMMENDED AS RESISTANT TO WEAR AND CORROSION

by LEONARD BOISEN
Spokane Army Air Depot

▪ Spokane Group, Jan. 12

(Excerpts from paper entitled "Chromium Plating")

INDUSTRIAL uses of hard chrome plate owe their existence to the unique combination of properties possessed by the deposited metal and which are not found in other methods of hardening. Electrodeposited chromium also has an especially low coefficient of friction, high seizure resistance, and high corrosion resistance when plated to sufficient thickness.

Best results are obtained in some cases with relatively thin chromium plate on a hardened steel foundation metal. Examples of this are metal cutting tools with the edge

properly prepared prior to chrome plating. Thicknesses applied are generally 0.00001 to 0.0005 in., most commonly in the thinner part of this range. Heavier deposits of chrome are applied in other cases which may range upward in thickness to 0.010 in. and considerably more in special instances.

General practice is to apply from 0.002 to 0.005 in. thickness for a good bearing surface. An excess of from 0.002 to 0.003 in. must be deposited to permit grinding back to the finish size.

Hardness of chrome depends entirely upon the control of the bath and current density during deposition. Following are examples:

Appearance or type of deposit	Brinell Hardness
1. Bright, as commonly used	1000 to 1025
2. "Burned," nodules, not usable	1250
3. "Milky" due to low current density	775
4. "Matte" or dull from cold solution	575

Some other physical properties of electro-deposited chromium taken from various sources are:

1. Density (as deposited)	6.93
2. Density (after annealing)	7.10 to 7.15
3. Melting point	1920 C (3488 F)
4. Reflecting power	60 to 66%
5. Coefficient of expansion (as deposited)	Negative
6. Coefficient of expansion (annealed)	4.99 to 6.05 x 10^{-6}
7. Coefficient of friction sliding on chrome	0.12
8. Coefficient of friction sliding on babbit	0.13
9. Coefficient of friction sliding on steel	0.16

The real field of hard chrome plating between 0.001 and 0.010 in. A plate thi ness of from 0.0001 to 0.001 in. is con ered a flash plate and in most cases wil uniform and smooth enough to be used a buffing only.

Experience has shown that 0.003 thickness of plate will give satisfactory vice as a wear or abrasion-resistant coati To chrome plate a part for wear resistance should be ground 0.006 in. undersize on diameter, then plated 0.006 in. oversize the diameter and then finish-ground to about 0.003 in. thickness being required the grinding and finishing operation.

Time required for deposlting a requi thickness of chromium will vary, dependi upon the type of piece being plated, though the general run is from 0.002 0.005 in. per hr on the diameter, or a thi ness of 0.001 to 0.0025 in. per hr.

Grinding of chromium presents a som what different problem from grinding st Hard chromium is more easily ground w a softer, free-cutting wheel than might used for grinding hardened tool steel.

A good wheel for grinding chrome is aluminum-oxide type made up with a fined grade of oxide. These wheels made up with about 60 grain abrasive wi fairly open bond. The finish grinding sho be done with finer abrasive, aloxite 160- S30 wheels, using lighter cuts and using soluble oil as a coolant (a 40-1 water uble oil mixture).

Wheel and work speeds are similar hardened steel and hard chromium plati The wheel may be run at 2200 rpm with work turning at 200 rpm.

The practice of salvaging worn tools a parts is generally accepted by industry tod but it seems that the advantages of plati new tools and parts are still not recogni by many. Plated tools have been found last 5 to 20 times longer than those wi are non-plated.

Attack Problem of Passenger Comfort On Longer Flights

by CHARLES W. MORRI
AiResearch Mfg. C

■ 1944 National West Co Aeronautic Meeti

(*Excerpts from paper entitled "Passeng Comfort in Commercial Aviation"*)

PERFECT passenger comfort is provid in present-day commercial airlines for majority of travelers whose trips aver approximately 500 miles. This results fr the fact that most air travel is made und smooth air conditions. Rough weather

eady air conditions which frequently lt in stomach uneasiness is beyond the rol of the designer or pilot. Precautions nst such distress can be handled through uctions to stewardesses in giving ad- e aid to those passengers who may be eptible to air sickness.

Seats Lack Comfort

assenger seats in the DC-3 airplanes, ch currently handle 95% of all domestic ations, are comfortable for the average rt-haul traveler, but they are far from fortable for long-distance flights. It is, ever, impossible to design a seat which ually comfortable for all people, since ations in body proportions among dif- nt passengers means that no two pas- ers will fit alike into the same seat.

During overnight travel, passengers often ken from a sound sleep to find one or h of their lower arms have lost their feel- and mobility. Many experienced travel- advocate placing their arms inside of the n rests, which may prevent impedence to d circulation. It would be helpful if air- s would acquaint passengers with the edients which have resulted in greater nfort with other passengers.

The American Society of Heating and ntilating Engineers has stimulated much earch on the effects of temperature and midity on personal comfort. It has shown t comfort is greatest between relative air midities of 30-70%, and within the effec- e temperature range of 66 and 75 F in mmer, or between 63 and 71 F in winter. ese comfort ranges have been determined tests of many subjects and show that the rticular seasonal acclimatization of the man body results in comfort ranges differ- g during the various seasons.

Heating Problem Is Acute

This acclimatization makes the heating oblem particularly acute in air transport rk, because passengers who have been liv- g on the West Coast or in the South react fferently from those who have been living the Middle West or East. This narrows e band of effective comfort for aircraft thin a range of 68 to 71 F at a relative midity between 40 and 60%.

It is further realized that air at sea level y normally be about 40% humidity. Air 100% humidity at 30 F drops to about % humidity when raised to 70 F.

In the airplane this change is magnified ll further in that the amount of moisture altitude is considerably less than at sea vel. Also, the temperature at altitude is quently lower than at sea level. Conse- ently, atmospheric air which is originally % relative humidity at 30 F has a relative midity of less than 10% when warmed to F.

It has been reported that relative humidity an airplane flying at 10,000 ft over the rth Atlantic in summertime has been as w as 3 to 4%. This causes rapid evapora- n of moisture from nasal-oral membranes d from the eyeballs, resulting in parched ouths and sore eyes. These conditions are nsidered to be particularly detrimental to e health of the crew.

It is commonly known that each person is nerating body heat at all times. The aver- e heat loss is about 400 btu per passenger r hr. This means that in an airplane rrying 20 passengers, 8000 btu per hr are ng added to cabin heat.

The average person would lose about 1/10 lb of water per hr through bodily evaporation in a room of 70 F dry bulb temperature and 60 F wet bulb temperature. In most airplanes it is necessary to maintain a cabin dry bulb temperature of nearly 80 F because the air is so dry. Thus, radiation and convection losses are markedly reduced, while evaporation losses go relatively high.

It is evident that the future airliner presents many problems in improving the passenger's comfort.

Pressure cabins will make air travel more comfortable for cold sufferers. They will also reduce the effects of lowered pressure at altitude. They will permit flying above nearly all storms and bumpy air conditions which are the basic causes of air sickness.

Automatic temperature controls will produce more uniform cabin temperature with greater resultant comfort for the passengers. Humidity controls are also a necessity in adding moisture to cabin air in order that we may control the rate of dehydration of the passengers.

Further study is necessary on seat design with particular regard to proportioning and shape in the erect and reclining positions. More study is also needed on arm rests covering height, configuration, and cushioning.

Multiple Engines Cut Operating Expense, Extend Service, of Commercial Vehicles

by RALPH M. WERNER
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• 1945 War Engineering – Annual Meeting

(Excerpts from paper entitled "Possibilities of Multiple Powerplants in Motor Trucks")

A STUDY of dual-engined and single-engined trucks of equal power can best be demonstrated by actual comparison.

In the case of a tractor suitable for 50,000-lb gross train weight, this comparison will show the cost of a single 200-hp unit with the cost of two 100-hp units to be mounted in the same vehicle. Thus, for two 100-hp engines, the cost will be only 30% of the cost of one single 200-hp unit. Two 100-hp clutches will cost only 20% of a single 200-hp clutch and similarly the cost of two 100-hp transmissions will only be 22% that of one single 200-hp transmission. The cost of a rear axle for the dual-engine drive is likely to be about the same as an equivalent axle for a single-engine drive. This is so because even though the power is applied at two separate places, it has been found practical to build these units in such a size, using the single reduction type of gear construction.

Some other details of comparison concern bearing pressures. It appears to me that bearing pressures are about identical in both the single 200-hp unit and the individual 100-hp units. The unit pressure and surface speeds are less in the double engine arrangement. The clutch for the 200-hp unit seems to be a little more adequate than those normally furnished for 100-hp engines. Transmissions for the two 100-hp units seem to indicate a factor of safety over the single 200-hp transmission.

Also, two smaller units so reduce the weight of the parts that they may be moved by a mechanic without the inconvenience of rigging up a hoist or some other special lifting apparatus. For example, the 100-hp transmission weighs about 150 lb whereas the 200-hp transmission will weigh about 480 lb. Further, the inconvenience and expense of road failure due to a powerplant failure is almost entirely eliminated with the two-engine type of construction.

I have noted on tests I have conducted that the total drag of an engine at any speed is virtually independent of load. For example, when we ran a test at 2500 rpm and deducted the brake horsepower from the indicated horsepower, we got the resulting friction horsepower. When we took the same engine and used a dynamometer to motor it, in order to secure friction horsepower without any great internal pressure being produced, this friction figure was almost identical with that previously developed under full load. The advantage here is definitely in favor of the two individual engines, as they can be operated as required.

Another benefit to be gained by the use of two powerplants in the vehicle under consideration is the saving in weight, about 1000 lb. In many instances this would permit the earning of several thousands of dollars in extra revenues where the loads are restricted by law.

The second form of dual-engined vehicle to consider is the type in which an extra engine is added to increase performance. For instance, if a truck were constructed with two powerplants and the savings mentioned above were not taken advantage of, but the approach were made to provide more horsepower, a truck of superior ability would result.

In the case of transmissions, considerable saving of wear and expense of maintaining these units should result because the transmissions will not be used to such a degree in the lower gear. Generally, low gear usage is the index to the life of a transmission.

Fixed operating expenses, such as drivers' and helpers' wages, garage rent, insurance, licenses, and taxes often represent the major portion of the total. If these expenses are expressed on a ton-mile basis, it will be easy to recognize the substantial reduction due to the greater ton-mile potentiality of the two-engined vehicles.

The third approach to the dual-engine problem is an adaptation of the form that includes an extra engine for increased performance. The Clark automatic booster unit has been successfully applied to a number of

...d and Chevrolet 1½-ton tractors. An ...liary engine is located between the in... of the right-hand frame rail and the ...peller shaft at a point slightly ahead of ...e rear spring front bracket. From this ...gine, by means of an overrunning clutch ...d propeller shaft, the power is put into ...e countershaft of the transmission by use ...f a power take-off. This method adds ...rsepower and torque to the countershaft ...d permits its use and application through ...ars up to the mainshaft in the usual ...anner.

The idea has merit in that it does not ...quire any synchronization of gear shifting ...rangements. The overrunning clutch fea...re eliminates the need for disengaging the ...xiliary engine at any time when the truck ...s operating without it.

Control of the starting and stopping of ...e booster engine is entirely automatic, gov...rned by conditions of load on the main ...gine. The booster operates also to provide ...ster acceleration to normal speed after a ...owdown or stop, and so is of advantage in ...ongested traffic areas, saving time and help...g to maintain a rapid, unimpeded flow of ...affic.

On grades so steep that even with both ...e main engine and the booster engine in ...se it becomes necessary to use a lower gear, ...e shifts are made in the ordinary manner, ...d the booster engine still assists the main ...gine.

Motor Coaches Get Speed and Agility From Dual Engines

by F. R. FAGEOL
Twin Coach Co.

▪ 1945 War Engineering-Annual Meeting

(Excerpts from paper entitled "Advantages of Multi-Powerplants in Motor Buses")

MULTIPLE powerplants should be used in a motor coach when the trends of traf...ic indicate that higher performance is neces...ary and that original cost, lower weight, better performance and better operating ...conomy can be obtained by use of dual ...owerplants rather than by the use of a ...arge single engine.

At the present time there are no commer...ial gasoline or diesel engines available which ...re suitable for installation in motor buses ...hat exceed 175 to 180 hp, and there are ...o commercial transmissions or rear axles ...uitable for installation in motor buses which ...will handle in excess of 175 to 180 hp.

There are at present two popular loca...ions for engines in motor buses; amidships ...nder the floor of the vehicle, and in the ...xtreme rear end of the bus back of the ...ear axle. It is almost impossible to install ...ngines larger than those used now and de...veloping 175 to 180 hp in the extreme rear ...end of the coach, because such installation ...equires the engine to be placed laterally or ...rossways in the bus. In addition to the ...ngine, space must be found for transmis...ions, clutches, radiator, and other acces...ories, because, in a vehicle 96 in. wide or 35 ft in overall length, the manufacturer does not dare interfere with or sacrifice seating space.

By using two engines in place of one in the motor, we have increased power and performance and have accomplished the following:

Designed a special medium-size engine of 404 cu in. capacity which, when operating at 8 to 1 compression ratio and on 80 octane gasoline, develops at 2400 rpm, 167 hp, and 375 ft-lb of torque, and which has a rating of 140 bmep at maximum torque condition.

This engine, which was designed for use as a multiple powerplant mounted amidships under the floor, is so constructed that by simply reversing the block it can be made into a right- and left-hand engine, so that the intake manifold and carburetor are on the top side and the exhaust manifold is on the bottom side of both the right- and left-hand engines. The spark-plugs, valves, carburetors, and so forth, are on the extreme outside of the motor coach on both the left- and right-hand engines.

These engines equipped with intake manifolds, carburetors, distributor, starter, bell-housing, flywheel and exhaust manifold weigh 840 lb each – so with a total weight

of 1700 lb for powerplants, we are able to install in a coach over 325 gross hp, or about 300 net hp after deducting all accessories. This 1700 lb equals approximately the average weight of the present-day single engine developing 175 to 180 hp.

After providing the dual engines, it is then necessary to provide dual transmissions to go back of them, or a separate transmission for each engine. The weight of these transmissions will be about 350 or 375 lb each. As against this, it is questionable whether or not a single transmission capable of handling some 750 ft-lb of torque and 300 net hp could be built for any less weight.

Regarding the rear axle, we constructed a dual drive using a hypoid bevel-gear type rear axle wherein we had a gear and pinion driving each rear wheel by each motor totally independent of the other. Thus, we have built a rear axle capable of transmitting to the wheels a total of 300 net hp at a weight which is within 50 lb of the weight of the rear axle necessary to transmit 175 hp.

The whole motor coach structure and the special structure necessary for mounting the powerplants, and so forth, can be made lighter when using two small relatively lightweight powerplants, rather than one large heavy powerplant, because less weight is concentrated in any one place.

As a result of these combinations, it is possible and practical to produce a motor coach having over 300 net hp wherein the total weight of the job will not be any greater than in the best designed present-day jobs having a total of approximately 175 hp and much lighter than most present-day motor coaches having 175 hp.

While a slight sacrifice is taken in friction loss when using two engines approximating a total of 808 cu in. against a single engine of equal size, this loss is more than offset by the considerable higher thermal efficiency inherent in the smaller size engine due to better induction and breathing.

The average motor coach of today equipped with 175 hp is capable of an acceleration rate of approximately 2 to 2½ mph per sec, whereas against this the modern trolley coach is capable of an acceleration of 3½ to 4 mph per sec, and against this the average present-day touring car is capable of an average of 4 to 5 mph per sec at the start.

Higher horsepower and higher acceleration and performance represent a "must" in the motor coach of the future if the operator is to continue to hold his present business and develop future business; otherwise, the motor bus is bound to become a menace to other traffic in highly congested areas, and on long grades throughout the country.

BRITISH PROPOSE BASIC PRINCIPLES TO INSURE PRACTICALITY OF DESIGN

by C. A. GLADMAN

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▪ 1945 War Engineering-Annual Meeting

(Excerpts from paper entitled "Drafting Room Practice in Relation to Interchangeable Components")

ONE of the most important stages in the manufacture of an interchangeable product is that of design. The designer must analyze the structure and mechanical moments, determine clearances and tolerances, provide for interchangeability, insure economy of manufacture, and state acceptance conditions for each component clearly on the drawing.

Only few attempts have been made to assist the designer to reason along logical practical lines, and to establish fundamental principles with which the solutions for various types of dimensional problems can be most effectively approached. Lack of knowledge in the design stage has led to extreme difficulties in practice, and has often been a "bottleneck" in production, owing to the fine gage tolerances required by the components.

If practical aspects had been sufficiently appreciated, often these difficulties could have been reduced.

Establishment of basic principles, together with amplification and precise definition of drawing vocabulary is demanded.

Careful study of the problem by the British Admiralty resulted in a proposal that a code be written which is, in effect, a drawing dictionary. The ten basic principles which constitute this proposed codification cover:

Dimensions and Tolerances for both universally interchangeable features and for locally interchangeable features; Position, Concentricity, and Symmetry for universally interchangeable features, for grouped features, for locally interchangeable features, and for universally and locally interchangeable features; and Angles, Polygons, and Profiles, for the four classes of features mentioned above.

Discussion

Engineers readily agreed that the proposal suggested by Mr. Gladman was an important contribution to the advancement of mass production, but a number of designers were apprehensive of the vast amount of educational work required to bring any such code into common practice.

Several American engineers pointed out, for example, that depending upon the specific type of tooling involved, drawings in this country tended to differ even when the end product was the same. On this point, for example, one engineer pointed out that considering general experienced trends and tendencies consequent to specific processing or manufacturing schemes, and the probable tooling of each part, tentative limits are stacked and studied. Should closer limits be indicated, often the cheaper parts are fixed up first in an attempt to get good functioning of the component at least cost. If still unsuitable, the whole thing is tried out to see if it works properly. In this country, he said, fits are preferably determined by test.

It was repeatedly emphasized that a reduction, rather than an increase, in code symbols is needed. Several designers held that notes, expressing the requirements in simple and unequivocal words, were more preferable than the introduction of new symbols. Thus the designer, master mechanic, machinists, tool operators, and inspectors would understand clearly what was required.

A discusser from Great Britain pointed out that two main systems are in vogue there, that is, first and third angle projection. He

that the proposed system of code symbols would resolve that conflict, and hoped that careful study be given to this research with the hope that some form of international standardization of drafting room practice might be evolved thereby.

(Note: Copies of Mr. Gladman's paper are available from SAE Headquarters: 25c to SAE members; $1.00 to non-members.)

Standardize Dusts For Use in Making Air Cleaner Tests

by JOHN T. LIGGETT
Allis-Chalmers Mfg. Co.

St. Louis, Oct. 10

(Excerpts from paper entitled "Air Cleaners on Crawler Tractors")

MODERN air cleaner installations on tractors which must operate in dusty conditions usually consist of an oil bath cleaner and a pre-cleaner on an elevated stack. The height of this stack is made as great as possible to place the inlet at a level where the air contains as little dust as possible.

Castings which are used must be sound and free from porous sections through which dusty air would be drawn by the high suction on the inside. Gasketed joints must be carefully made to insure their tightness. Flexible metallic tubing of the spiral-wound type are not trustworthy for connections between air cleaners and carburetors. A better construction is to use formed solid tubes with rubber hose and clamps where the flexure occurs. If spiral-wound tubing must be used, it should be carefully taped and shellacked. Butterfly shafts in carburetors must fit very snugly as a gap of only a few thousandths will allow the entrance of as much dust as would be passed by a good air cleaner installation. Leaks in the intake air system are very difficult to locate because of the inward flow of air and the high air turbulence around the engine.

Test Dust Is Critical

In laboratory tests the dust used must be carefully prepared to give data which can be compared with other tests. The SAE Recommended Practice does not insure the presence of the small dust particles which are so necessary to prove the efficiency of an air cleaner.

To meet the need for a standardized test dust containing a larger and a known percentage of the finer particles than is normally found in dust, the AC Spark Plug Division has manufactured two grades of standardized dust, fine and coarse. Selected Arizona dust is ground in a steel-lined mill until the desired percentage of 5 micron dust is present, and by blending batches they can meet the standard gradation.

Effect Demonstrated

The effect of these smaller particles on the efficiency of air cleaners is shown by the following test which used the two finer grades of dust in succession in the same air cleaner. The fine grade of the AC Spark Plug has been accepted and called Ordnance

standard dust, for testing air cleaners on military equipment.

	Allis-Chalmers Dust	*Ordnance Dust*
Pre-Cleaner Efficiency	92.3	55.2
Air Cleaner Efficiency	99.3	82.4
Overall Efficiency	99.75	92.05

Tests indicate that dust particles 0 to 5 and 0 to 12 microns in diameter cause a more rapid deterioration of the engine than similar particles 0 to 40 microns in diameter. It is these smaller particles which the air cleaners are unable to absorb and hold.

How Dust Quantity is Determined

To determine the quantity of dust entering an engine, we can assume a pre-cleaner efficiency of 75% and an oil bath cleaner efficiency of 95%, giving an overall efficiency of $0.75 + (0.25 \times 0.95) = 98.75\%$. The quantity of dust entering an engine can be determined by the following: a General Motors 6-71 engine operating at 1500 rpm will draw 516 cu ft of air per min. The formula is volume of air in cubic feet per hour multiplied by the dust in grams contained in 100 cu ft multiplied by the per cent of dust passed, which equals the quantity of dust entering the engine in grams per hour.

Substituting the above conditions in the formula, the figures become $\frac{30960}{100} \times 2$ ... $1.25 = 7.74$ g per hr, which is an appreciable amount of dust to be fed into an engine.

Clean Engines Lead to Long Wear

Our experience with General Motors engines in the field showed that where pre-cleaners would fill up in 15 min, rapid wear of the engines resulted – sometimes after only 200 hr of operation. However, we have instances of identical engines operating in the laboratory where the air is relatively free from dust for a period of 5000 hr with only 0.002 in. maximum wear. Thus, the service which can be secured from an internal-combustion engine is directly proportional to the effectiveness of the air cleaners.

The tractor manufacturer should consider the following points for effective air cleaner installation for an internal-combustion engine:

1. The point of air intake must be located where the atmosphere is as free of dust as possible.

2. The accumulation of dust in the pre-cleaner should be visible to the operator.

3. The oil bath cleaner must be small enough to insure that the filter will be oiled at light engine loads.

4. The oil bath cleaner must be large enough so oil will not be pulled over under any operating condition.

5. Servicing should be convenient without the use of wrenches or special tools.

The tractor operator must take care of the following items in servicing:

1. Empty the pre-cleaner as often as it fills up.

2. Service the oil bath according to the operating requirements.

3. Periodically inspect the inside of the air passage to the engine to check for dust which will indicate leaks or defective cleaning.

4. Make all air intake joints tight.

Infra-red Pits Warm Bus Engines

by R. H. DALGLEISH, Jr.
Philadelphia Transportation Co.

■ Metropolitan, Feb.

(Excerpts from paper entitled "Infra-Red Rays – They Put the Heat on the Outdoor Storage Problem")

THE success of infra-red heating in industrial applications pointed to this means of heating as a possible solution to the problem of heating bus engines for outdoor storage. Accordingly, experiments were conducted by Philadelphia Transportation Co.'s research department to determine the suitability of this form of heating.

n order to determine the minimum starting temperature of a bus in average condition, tests were conducted on an ACF 31-S n, taken from regular service in which an E 30 grade of oil with a pour point of F was used. It was found in most cases t the cranking speed of the engine under own battery was not sufficient to start en the cylinder wall temperature was w about 25 F and the crankcase temperature below about 50 F. It was recognized that the viscosity of oil used and the gine condition would cause variations in rting temperatures, which fact was taken o consideration.

Two methods of heating were considered:) where heat was applied after the bus gine had been allowed to cool to the storage temperature; and (2) where heat was plied, after the engine had been operated, retard the radiation of the normal engine at. Results of tests which were conducted duplicate these conditions so as to determine the heating capacity required in each se follow:

Heat Applied to Bus Engine Cooled to Storage Temperatures

Storage Temperature, F	Capacity Required, kw	Time Required to Obtain Starting Temperature, hr
−10	3	4
0	2	4
10	1	6
20	1	2

Heat Applied to Bus Engine to Retard Radiation from Operating Temperature

Storage Temperature, F	Capacity Required, kw	Time Required to Balance Above Starting Temperature, hr
−10	2	6
0	1	8
10	1	6
20	1	2

It was decided as a result of these tests at economically it would be desirable to tard the radiation of the natural engine eat by the use of infra-red heat during orage since the buses would enter storage om service with engines at operating temperature. A lower installed capacity would be required and the first cost of the installation and demand charge for current would be less. The kilowatt-hours used for heating during storage would be about the same nd a more constant engine temperature would be maintained.

Experimental Installations Described

A preliminary installation was made to accommodate 27 buses maximum at the garage location. Parking berths were laid out and small pits were properly located at these berths to contain four 250-w infrared lamps. The lamps were controlled by a simple fuse switch circuit panel board located with the main switch and meter equipment in a small 5x7x7 ft weatherproof wood house. The wiring from the panelboard to the bus pit was run in conduit with an individual circuit for each parking location.

This experimental installation for 27 buses cost about $3000, or $107 per bus. Construction of a more permanent nature, such as concrete pits with tile drains, might cost approximately $200 per bus.

When excessive lamp breakage was experienced in the initial period of installation, hard glass lamps were tried and proved satisfactory. It is expected in the future type R-40 drying lamp will be available in hard glass.

It is apparent that the cost of heating with infra-red heat is considerably lower than heating by idling the engines, considering the cost of gasoline, labor for starting and stopping the engines, and wear on vital engine parts due to the dilution of the lubricant caused by idling operation.

Savings Effected

It is estimated that about 5000 gallons of gasoline were saved in this operation as well as about 5000 engine operating hours at a time when these items are most important.

Infra-red heating was developed for the under-floor engine and lends itself well to engines in this location. This form of heating should be attractive only to those operators in milder climates where indoor storage would only be necessary for short periods during the winter, and where temperature does not remain low for protracted periods during the winter.

Peacetime Plane Is Army Veteran

by E. F. BURTO[N]
and CARLOS WOO[D]
Douglas Aircraft Co., In[c.]
■ 1944 National West Coa[st]
Aeronautic Meeti[ng]

(*Excerpts from paper entitled "The Desi[gn] of the DC-4/C-54 Airplane"*)

WITH the approach of war it was advis[able] to make use of airplanes already [de]signed and under construction. According[ly] contracts of the DC-4 (designed for a gro[up] of domestic airlines just prior to the wa[r)] were taken over by the military autho[rities] and the airplane was rechristened the C-5[4].

Design accomplishments of the DC-4/C-5[4] are as follows:

1. *Safety.* Design of the DC-4/C-54 su[r]faces provides stability and control over [a] large range of center-of-gravity positions. [A]ll control surfaces are statically balanced b[y] elements, which effectively isolates the co[n]trol surfaces from the vibrating system a[nd] assists flutter prevention. This static bala[nce] serves another useful purpose in helping t[he] preservation of proper control forces for [the] pilots, as control surface moments from a[c]celerations in flight are reduced to zero.

The basic wing design of the DC-4/C-5[4] series is such that the airplane shudd[ers] slightly at speeds somewhat above the sta[ll,] giving a stall warning. If the warning [is] not heeded, the airplane will stall with co[n]tinued lateral control and nose down, a[nd no] falling off on either wing.

Maneuvering of large aircraft on t[he] ground has always been a problem, and [as] a result, the C-54 gear was designed wi[th] a steerable nose wheel.

Powerplant design has long been a sou[rce] of worry about safety. Inflammable flu[ids] must be piped to it for fuel and lubricati[on.] Accordingly, in addition to carbon dioxi[de] fire extinguishing systems, fluid shut[off] valves are incorporated aft of the firew[all] in order to allow shutting off of all flu[ids] prior to operation of the fire extinguishi[ng] system.

2. *Utility.* The designer can do much t[o] reduce fuel consumption by cleanness [of] aerodynamic design. Thus, such things ha[ve] been developed as flush rivets, flush sk[in] joints, flush windshields, low-drag engi[ne] cowling, and complete sealing of structu[re.]

The tricycle landing gear of the C-54 per[]mits a level floor, allowing for easy positio[n]ing of heavy cargo. Adequate floor streng[th] is provided to permit carrying of heavy co[n]centrated loads. Flexibility is provided f[or] the carrying of passengers or cargo as re[]quired, or for use as an ambulance plane.

3. *Controls.* Ease of control has be[en] found to be particularly important, especi[ally] in large long-range aircraft. After mu[ch] study, it is felt that with proper design pra[c]tice, it should be possible to control aircr[aft] up to about the 500,000 lb. class witho[ut] power boost. A system with low deflecti[on] under load, and with an absolute minim[um]

friction is the result of careful initial layout to allow long cable travel and the fewest direction changes in cable routing.

The elevator control system runs under the cabin floor, from the pilot's compartment to the elevators, with a minimum of bends and pulleys, the section under the cabin being straight with no pulleys for a run of 65 ft.

The rudder control system is similar. The aileron control system runs directly to the "main aileron cross" located aft of the wing center spar, and then directly to the aileron control mechanism, running over pulleys only at one point to correct direction for the wing dihedral.

Trimming controls, powerplant, and other control systems run as directly as possible between the controlling and controlled points.

4. *Powerplant.* Two main problems occurring in powerplant installations are those of vibration and heat. Vibration is now just about under control because of the adaptation of the floating power principle. This reduces local structural failures and resultant maintenance.

Due to inefficiencies of usable heat cycles, there is a large amount of heat to be dissipated within the confines of a small space. Control of this heat dissipation is very important, as the drag associated with cooling may be drastically reduced, thus improving the aerodynamic drag characteristics of the airplane.

5. *Structure.* Simple structure usually pays off in reduced weight if properly designed. Consider the inner and outer panels of the DC-4/C-54. All load carrying members are simple and direct. Joints and intersections are kept to a minimum. The design is such that machine riveting may be used on hat-sections and skin panels that comprise the covering, as well as on the spars. The whole structure breaks down for dispersed subassembly, making for high production and reduced manpower and facility requirements.

The fuselage follows the same basic breakdown. In addition, the load-carrying portion of the fuselage is of a constant section, eliminating double-curved skin panels, and permitting the use of straight stringers. Such an arrangement allows the utmost flexibility in interior arrangement.

Fixed tail surfaces are designed with no spanwise members but the spars, which attach to the fuselage by tension bolts. This eliminates intersections, and allows panel assembly of all parts of the tail structure.

6. *Mechanical Devices.* These devices should be installed in the airplane only to the extent required to operate the airplane with safety or with added utility. In any case, they should be simple, light, and designed specifically for the use intended.

7. *Equipment.* Operating units and controls of necessary equipment must of necessity be located for easy maintenance and use. For example, batteries are suspended on elevators for ease of replacement and check.

Recent reports have indicated that average flight time from C-54 series airplanes is now running as high as 11 to 13 hr. per day. It is obvious that this extremely high utilization of equipment indicates that the design fundamentals of the airplane must be essentially correct, particularly when it is recalled that pre-war utilization of airline equipment generally did not exceed 6 to 7 hr. per day.

About SAE Members

cont. from p. 24

of General Motors Overseas Operations, to New York; and **RAY C. ROLPH,** from assistant district manager, Willard Storage Battery Co., Dallas, Tex., to district manager.

RICHARD B. COLE, formerly director, Standard Motor Co., Ltd., Coventry, England, is now managing director, Sunbeam-Talbot, Ltd., London, England.

Formerly chief engineer, Pump & Compression Division, Rogers Diesel & Aircraft Corp., New York City, **ALBERT FOWLER** is now consultant to American Engineering Co., Philadelphia.

THEODORE HEIL is now with The Texas Co., Lodi, Calif., as a consignee. He had been lubrication sales engineer, Union Oil Co. of Calif., Emeryville, Calif.

DANIEL A. MARSHALL, JR., is no longer with Chrysler Corp., Highland Park, Mich., as layout draftsman in the engineering department, having joined Packard Motor Car Co., Toledo Division, as aircraft engine designer.

GRANT W. KELLER, a former student of Purdue University, is now in the U. S. Navy, and may be reached at Omaha, Neb.

Formerly project engineer, Pesco Products Co., Cleveland, **JOHN L. NAGELY** is now employed by Packard Motor Car Co., Toledo, Ohio, in the same capacity.

ENSIGN RAY M. KOLB, USNR, is stationed at San Diego, Calif. In civilian life he was liaison engineer, Wright Aeronautical Corp., Lockland, Ohio.

GEORGE J. LIDDELL, who had been research engineer, Continental Aviation & Engineering Corp., Detroit, is now development engineer, Sun Oil Co., Marcus Hook, Pa.

FREDERICK W. HEISLEY has joined Wheel & Rim Sales Co., Pittsburgh, Pa., as manager. He formerly held the same position with Joseph Woodwell Co., same city. Mr. Heisley is a past-chairman of the SAE Pittsburgh Section.

LOUIS M. PAWLETT is no longer an engineer in the Electronic Instrument Division, Manning, Maxwell & Moore, Inc., Bridgeport, Conn., having joined the spare parts department, Sikorsky Aircraft, Division United Aircraft Corp., same city.

HUGH F. SCOTT has resigned from Frazier Wright Co., Los Angeles, where he was general superintendent, to become general plant manager, Precision Engineering Co., same city.

WILLIAM A. KELLY is now a first lieutenant in the U. S. Marine Corps, and he may be reached at the Aviation Ground Officers' School, Quantico, Va. Before entering the service Lt. Kelly was liaison engineer, Pullman-Standard Car Mfg. Co., Aircraft Division, Chicago.

APPLICATIONS Received

The applications for membership received between Jan. 10, 1945, and Feb. 10, 1945, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section: William Hamilton Boyd, Gustave William Matlat.

Canadian Section: Stanley Allen, Ernest W. Bartle, George Tay Berner, Alfred H. Glionna, Stewart Wallace Irvine, William Douglas Laird.

Chicago Section: Sanford L. Beckwith, Mark L. Blair, Merle W. Bloom, Guy B. Child, Arthur A. Friestedt, Nelson J. Gothard, Seymour Edward Heymann, C. V. Landwerlen, Joseph Charles Lepic, Mortimer J. Lowy, Thomas J. Thompson, Morton E. Weldy, Charles E. Wolmer.

Cincinnati Section: Fred W. Biederman, Robert C. Dall, J. H. Garlough, Harry C. Larick, James J. McGraw, Harold D. Littlejohn, Ward N. Shaw, F. E. Whitacre, Jr.

Cleveland Section: L. K. Acheson, Anthony Colnar, Karl R. Feise, Warren L. Gilmore, Lyle W. Hodson, Harold J. Knaggs, Scott Rethorst, Joseph Harry Rosenberg, John W. Tatter, John E. Ullman, Frederick Norton Williams, Arthur Whitsel Woodward.

Colorado Group: Strawn Armstrong.

Detroit Section: Freedom H. Ainsworth, Harvey J. Anschuetz, Albert D. Baker, Arthur C. Bodeau, Charles Edwin Stratford Chapman, Paul J. Connell, Charles S. Davidson, Charles S. Davis, Jr., Robert H. Duff, C. Ernest Briggs, Blaine E. Eynon, Henry H. Gotberg, Emile P. Grenier, Wallace McQuown Grube, Joseph Gurski, Joseph M. Gwinn, Jr., Alex Hardy, Frank R. Hinchcliff, Raymond A. Hudson, Ernest L. Keller, Frank K. Kirsch, Joseph S. Laird, James S. Lanham, Edward Lassila, Ford G. Martin, Audy F. Mason, Cyril C. McAdams, Don D. Mott, A. Emmet Nix, Bernard A. Peterson, Jr., George Alexander Preston, Russell W. Rieck, Earl F. Riopelle, Albert O. Roberts, Frank LeRoy Schwartz, Edwin D. Scott, Robert E. Sharpe, Edward Shouskey, George R. Smith, Gordon R. Swanson, Paul Alfred Thorlakson, C. I. White, Gerald D. Wilson, Anthony E. Wisne, Philip C. Wood.

Indiana Section: Kenneth M. Armantrout, J. H. Coover, James M. Fadely, Thane E. Houser, Herbert E. Oles, Edward Swain Russey, Raymond W. Semmler, Gene P. Stonecipher, Daniel B. Worth.

Kansas City Section: Edward S. McCarthy, H. E. Toot.

Metropolitan Section: Mark C. Benedict, John P. Bertram, Carl E. Habermann, Gordon W. MacKinney, Michael A. Mavlens, Stuart Merkel, David W. Moore, Jr., Morris Rosenberg, S. J. Steven, Richard Ernest Steward, Emery I. Valyi, George S. Wheat, Jr.

Mid-Continent Section: Richard Champney Alden, George W. Cupit, Jr., Robert W. Henry, S. B. Ingerson, G. G. Oberfell.

Milwaukee Section: L. D. Watkins.

New England Section: Samuel F. Derby, H. E. Marvill.

Northern California Section: Louis Aa, Arthur C. Bolton, George K. Floroff, Kenneth U. Meguire, George H. Reading.

Northwest Section: C. D. Davis, Dan R. Huntington, Jr., Robert B. McMullen.

Peoria Section: George H. Gearhart, J. Dean Uhll.

Philadelphia Section: Earl George Bennett, Robert W. Donahue, Charles E. Fogg, Brendan J. Fraher, W. F. Gittler, Emerson D. F. Ogle, Jacob L. Pauly, Joseph R. Rowland, F. J. Sargent, Leonard A. Stewart, Harry Tabachnick.

Pittsburgh Section: Frank W. Godsey, Jr., Carl F. Harms.

St. Louis Section: Howard W. Benjamin.

Salt Lake City Group: Virgil E. Lyman, William LeRoy Pullman.

Southern California Section: Leslie H. Appel, W. Kenneth Belisle, Arthur L. Birdsall, Jr., Donald T. Boody, Donald [illegible] Carr, Robert Lloyd Coleman, C. B. Cooper, Ralph Stuart Gibbs, Robert A. Hoffman, W. Sheldon Keefer, Emanuel Kessler, Thomas R. Lansing, E. Gilbert Mason, John P. Mathias, William Ralph Mayhew, Donald G. Moore, Edward Michael Nash, Frank H.

continued on p. 48

SAE Coming Events

Baltimore – March 8

Engineers Club; dinner 6:30 p.m. Synthetic Tires As They Affect Our Transportation Problems – W. H. Elliott, manager, field engineering, B. F. Goodrich Co.

Buffalo – March 14

University Club; dinner 7:00 p.m. Ladies Night. Motion Pictures. Presentation of certificates to Past-Chairmen.

Canadian – March 21

Royal York Hotel, Toronto; dinner 6:30 p.m. Automotive Decision – J. M. Crawford, chief engineer, Chevrolet Division, General Motors Corp. and president, SAE. Guest – John A. C. Warner, secretary and general manager, SAE.

Chicago – March 13

Knickerbocker Hotel; dinner 6:45 p.m. Speaker and subject to be announced.

Cincinnati – March 20

Alms Hotel; dinner 6:30 p.m. Automotive Foundry Practice – Hiram Brown, Aluminum Industries. A. T. Colwell, vice president, Thompson Products, Inc. Subject to be announced.

Cleveland – March 12

Cleveland Club; dinner 6:00 p.m. Powder Metallurgy – R. B. Aufmuth, project engineer, S. K. Wellman Co.

Colorado Group – March 13

Continental Oil Bldg.; meeting 8:00 p.m. The Human Side of Steel – W. B. Jacobson, Colorado Fuel and Iron Corp.

Detroit – March 5

Horace H. Rackham Educational Memorial Bldg.; dinner 6:30 p.m. History of the Dodge Chicago Plant – L. L. Colbert, general manager, Dodge Chicago Plant. China and the Burma Road – D. F. Myers, Studebaker Corp.

Indiana – March 8

Antlers Hotel, Indianapolis; dinner 6:45 p.m. Engine Oil Consumption Determination. Illustrated with slides and other visual aids – Karl H. Effmann, supervising test engineer, Perfect Circle Co.

Metropolitan – March 1

Pennsylvania Hotel, New York; meeting 7:45 p.m. Water-Alcohol Injection for Spark Ignition Engines – A. T. Colwell, vice president, Thompson Products, Inc. Solid Injection of Gasoline Engines – Harry O. Hill, gasoline injection engineer, American Bosch Corp.

Milwaukee – March 2

Milwaukee Athletic Club; dinner 6:30 p.m. Allison Aircraft Engine – R. M. Hazen, chief engineer, Allison Division, General Motors Corp.

New England – March 6

Engineers Club, Boston; dinner 7:00 p.m. Ball Bearings Do Not Commit Suicide – And Very Few Die of Old Age – T. C. Delaval Crow, chief engineer, New Departure Division, General Motors Corp. Motion Picture – Ball Bearings.

Northwest – March 2 and 23

March 2 – Gowman Hotel, Seattle; dinner 7:00 p.m. W. K. Creson, chief engineer, Ross Gear & Tool Co. Subject to be announced.

March 23 – Gowman Hotel, Seattle; dinner 7:00 p.m. Wartime Maintenance of Rings, Pistons and Cylinders – P. Kornafel, American Hammered Piston Ring Division, Koppers Co.

Oregon – March 2

Imperial Hotel; dinner 7:30 p.m. Effect of Fuel Development on Post-War Automobiles – A. T. Colwell, vice president, Thompson Products, Inc.

Peoria – March 19

Jefferson Hotel; dinner 6:30 p.m. Helicopters – Betram Kelley, assistant director, Helicopter Division, Bell Aircraft Corp. Motion Picture. Joint meeting with ASME.

Philadelphia – March 14

Engineers Club; dinner 6:45 p.m. New Engineering Materials – P. B. Jackson, Aluminum Co. of America. Guests – J. M. Crawford, chief engineer, Chevrolet Division, General Motors Corp., and president, SAE. John A. C. Warner, secretary and general manager, SAE.

Pittsburgh – March 27

Mellon Institute; dinner 6:00 p.m. Porous Chrome Plated Rings and Cylinders and Their Applications – Dr. T. C. Jarrett, chief metallurgist, American Hammered Piston Ring Division, Koppers Co.

St. Louis – March 20

Location to be announced; dinner 6:30 p.m. Transportation and Maintenance – Errol J. Gay, manager, commercial division, Ethyl Corp.

Southern California – March 8

Hollywood Roosevelt Hotel, Los Angeles; dinner 7:00 p.m. Development of a Light Transport Airplane Design – W. M. Hawkins, chief preliminary design engineer, Lockheed Aircraft Corp.

Southern New England – March 7

Bond Hotel, Hartford; dinner 6:45 p.m. Development of Motor Fuels – Fred E. Stockwell, Colonial Beacon Oil Co. Motion Picture.

Southern Ohio – March 20

Engineers Club, Dayton; dinner 6:30 p.m. Fly-Power – F. L. Prescott, principal mechanical engineer, U. S. Army Air Forces, Design and Development Aircraft Engines, Wright Field, Dayton, Ohio.

Spokane Group – March 9

Spokane Hotel; dinner 7:00 p.m. Electrical Accessories – Armond M. Baump, Service Manager, Gill Automotive Co.

Texas – March 16

Adolphus Hotel, Dallas; dinner 6:30 p.m. Plastics. Speaker to be announced.

Twin City Group – March 8

Curtis Hotel, Minneapolis; dinner 6:30 p.m. Diesel Engine Operation. Speaker to be announced.

Washington – March 13

Statler Hotel; dinner 7:00 p.m. Automotive Decision – J. M. Crawford, chief engineer, Chevrolet Division, General Motors Corp. and president, SAE. Guest – John A. C. Warner, secretary and general manager, SAE. Col. Fred Glover, chief, automotive section, War Production Board. Subject to be announced. Presentation of certificates to Past-Chairmen.

Western Michigan – March 15

Occidental Hotel, Muskegon; meeting 7:30 p.m. Metals and Alloys for High Temperature Service – Dr. O. E. Harder, assistant director and supervisor of research in physical metallurgy, Battelle Memorial Institute. Joint meeting with ASM.

Wichita – March 7

Wichita High School East; meeting 8:00 p.m. Imagineering – W. B. Stout, Stout Research Division, Consolidated Vultee Aircraft Corp.

Ramblings

cont. from p. 29

declared at **ST. LOUIS SECTION'S** Jan. 16 meeting that little engines are great stuff, that low load-factor is a gasoline waster, and that a fine way to boost gasoline mileage is to operate with the throttle wide open . . . To get acceptable automobile performance with the small engine, Mr. Pigott looks to the automatic transmission and 78-octane gasoline with present-day compression ratio . . . He called attention to cooling of the oil as being a major factor in prolonging not only oil life, but bearing life as well, and concluded by saying that the great improvements made in fuels and lubricants are no excuse for neglecting to improve mechanical design . . .

All the stages of magnaflux in the automotive industry – past, present and future – were reviewed by Magnaflux Corp.'s vice-president, C. E. Betz, at **MILWAUKEE SECTION'S** Feb. 2 meeting . . . Following talk was a display and demonstration of the application of a small portable magnaflux unit showing the magnaflux method of testing – the same as used in industry, and which is now brought down to a portable basis for service maintenance and overhaul work . . . Included also were black light and zyglow specimens . . .

Smith, Eugene L. Spearman, Jr., Frank P. West, Paul E. Williams, A. B. Wyrick.

Southern New England Section: George A. Flynn, Edward H. Granville, Henry Francis Hensel.

Southern Ohio Section: Carl E. Bagford, Robert W. Brown, Wallace A. Crismore, Capt. Walter H. Niles, Robert A. Wells.

Spokane Group: Ray Prentice.

Syracuse Section: Howard L. Hoke.

Texas Section: George F. L. Bishop, Felton Herschell Havins, W. P. Jones, Fred Marion Peterson, C. H. Wetzel.

Twin City Group: J. L. Becker, Stephen Crum, Hubert T. Sparrow, John Edward Ralls.

Washington Section: Edmond Louis Baker, Lt. Robert F. Berger, William Wheeler Brown, Joseph C. Diliberto, Robert Edison Fulton, Jr., Hugo H. Haas, Robert Morton Gitlin, Robert A. Riley.

Western Michigan Section: William G. E. Forsberg.

Wichita Section: Robert G. Sauder.

Outside of Section Territory: Clyde H. Ahlf, Sgt. Thomas C. Banks, Robert L. Campbell, William Donald Cheatham, Gifford Alexander Cook, Haydn Coryell, B. J. Eaves, Blaine E. Eisert, David George Gannon, Ronald A. Henderson, Clarence A. Kerner, W. J. Maze, T. Clifford Melim, John C. Mock, Frank C. Palmer, Sidney Herbert Paston, G. E. Ritter, Harrold H. Searing, A. C. Swygard, John E. Walker, Arthur F. Wallace.

Foreign: Joseph Dehoney, England; George Alexander Heslip, England; George Herbert Lanchester, England; John J. Roitt, England; Charles Trotwood Salt, England; Dr. Aly M. Shoeb, Egypt; Valentine Wilfred Stacey, Australia.

NEW MEMBERS Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between Jan. 10, 1945, and Feb. 10, 1945.
The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Buffalo Section: Everett Charles Curtis, Jr. (J), Erik H. Halvarson (J), Valentine D. Kauth (M), Bernard E. O'Connor (M).

Canadian Section: Sydney D. Ballard (A), Charles M. Birkett (A), Wallace J. Latchem (J), Roy A. McVey (A), Howard B. Moore (A).

Chicago Section: Arthur E. Anderson (A), Walter W. Black (A), Donald E. Burrows (J), T. Arthur Campbell (M), Juan Enrique Cintron (J), Donald S. Gray (J), Major Howard H. Herrmann (A), Leonard J. Koch (J), John R. LeVally (M), J. M. Morrow (A), Kenneth S. Oakley (M), Willard L. Pollard (M), Palm. E. Reichelt (J), Carl Edward Schmitz (M).

Cincinnati Section: Otto D. Gscheidle (A), O. Thomas Pfefferkorn (M).

Cleveland Section: Donald A. Barnes (M), Robert Laverne Gates (J), John J. Gaydos (J), Carl L. Harvey (M), (Miss) Elizabeth Thompson Izant (J), John R. Long (J), Rodney O. McSherry (M), Emil R. Mokren (J), Theodore J. Nussdorfer, Jr. (J), Benjamin E. Nye (M), Nick S. Pergakis (J), Franklyn W. Phillips (J), Milton Stahl Roush (M), Michael A. Sipko (J), Robert D. Spencer (M), William Glen Waltermire (M), John G. Wilson (J).

Detroit Section: Joseph C. Andreini (J), Otto H. Bartz (J), Frederick V. Bott (M), Harold Harrington Bush (M), George V. Candler, Jr. (SM), Arthur Edward Cox (M), Clifford H. Dixon (M), 1st Lt. Herbert J. Howerth, Jr. (J), A. R. Ketcham (A), James M. Leake (M), Charles Harold Lofthouse (M), William S. Logan (J), H. Richard Matheny (J), John J. May (M), Thad Mc Rae (A), William L. Park (M), Maxwell E. Salisbury (M), Robert W. Saylor (J), John C. Sterritt (A), James Edward Stockton (A), Frank Ready Swaney, Jr. (J), Rex A. Terry (M), Chester G. Venditty (J), Wilfred Williams (A), Sheldon F. Woodard (A).

Indiana Section: K. Carson Carroll (J), Lt. Robert D. Hogue (J), Perry W. House (M), Frank S. Jones (J), Ralph A. Shelly (A).

Kansas City Section: Harold F. Twyman (M), Byron L. Weiss (A).

Metropolitan Section: Albert K. Baum (A), Arthur Joseph Clark, Jr. (J), Rocco L. Cuzze (A), Irenee duPont, Jr. (J), Robert M. Durham (A), Charles J. Firmbach (A), C. H. Glasier, Jr. (M), Edward P. Grubel (M), John Hedley Hall (A), William Vincent Hanzalek, Jr. (J), John D. Hull, Jr. (J), Donald S. Johnson (J), Edward Kalustian (J), William Martin Kauffmann (M), Paul A. Koorbanoff (J), Timothy S. McGlynn (M), Earl B. Norwood (J), Robert H. Penner (J), Richard W. Shanklin (A), F. R. Truby (M), Kurt H. Weil (M).

Mid-Continent Section: John William Basore (A), Chester Howell Harris (A), Ed. Reily (A).

Milwaukee Section: Louis D. Caron, Jr. (A), L. H. Christiansen (A), Robert Cramer, Jr. (M), Howard A. Hoffman (M), John T. Jarman (M), W. W. Schettler (M).

Mohawk-Hudson Group: Lloyd C. Bower (A).

Northern California Section: Ensign John Winthrop Ellis, Jr. (J), Winston E. Winterbourne (J).

Northwest Section: Charles D. Bunce (A).

Oregon Section: Lt.-Col. Marlboro Kimmel Downes (SM), John Stanley Poulson (A).

Peoria Group: Frank A. Grooss (J), Walter J. McCulla (J), Arthur A. Zuhn (M).

Philadelphia Section: Martin Gilman (J), Lewis C. Kibbee (J), Roy F. Leiner (J).

Pittsburgh Section: Richard W. Vaughn (M).

St. Louis Section: Adolph J. Jeude (M), Frederick Thorne Sterling, Jr. (A).

Salt Lake Group: Clark Edwin Smith (A), S. V. Trent (A), Stanley S. Wojtkowski (A).

Southern California Section: Frank V. Beck (A), Joseph N. Carter (J), Tom J. Collins (M), Milton Feinberg (J), Howard Field, Jr. (M), Larry J. Halderman (A), Hamilton Herman (J), Lloyd W. Jedeka (M), Richard P. Joy (J), Charles S. Knotts (A), Fred O. Luenberger (A), Halbert S. Martinson (A), Eugene Michalczyk (J), Aubert M. Rice, Jr. (A), Rudolph F. Riesz (J), Robert D. Rothi (J), John H. Senter (J), Capt. Thomas J. F. Sherman (J), William Herbert Snow (M), Earl G. Spangler (M), Peter Ramsay Stitick (J).

Southern New England Section: L. H. DeWyk, Jr. (A), Edward Nesbitt (J), E. Sherman Smith (J).

Southern Ohio Section: George W. Heck (M), (Miss) Helen K. Hoskinson (J), Kenneth Ian Morton (A).

Spokane Group: J. G. McDonald (A), Thomas Harold Naismith (A).

Syracuse Section: Robert Irving Buckalter (J), William C. Candee (A).

Texas Section: Smith Lee Miller (A), Edward L. Stacey (A).

Twin City Group: John Griffith Davies (J), Geo. W. Martin (A), J. D. Mooney (M), Charles Arthur Nagler (M), David M. Roberts (J).

Washington Section: Thaddeus Walter Czuba (J), Squad. Leader Errol Kingsborough De Cean (M), Seymour J. Deitchman (J), Kenneth W. Elvin (A), Ernest F. Fiock (SM), Richard M. O'Boyle (J), Carl H. Roeder (SM), William A. Smith (A).

Western Michigan Section: Bernard H. Measley (A).

Wichita Section: Joe Howard Miles (J), 2nd Lt. John Fewson Smith (J).

Outside of Section Territory: Edward Burrowes Goodwin (A), Leon Eldon Greeley (J), Syvert A. Gunness (M), George L. Hartley (A), John Francis Hohl (J), T. E. Martin (M), Robert Quarrington Maxwell (A), Roger Clement Naylor (M), Robert William Nielsen (J), Byron R. Pool (A), Arnold Schindel (J), Ensign Leonard Velander, Jr. (J), Donald Collier Watts (J).

Foreign: P. A. Dyerson (A), (England), Wilfred Kenyon (FM), (England), Leonard Mills (FM), (England), John Stanley Orme (FM), (England).

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